Aviation Week
and Space Technology

July 25, 1960

Checkout Unit For Polaris Aids Reliability

Boom Operator's View of B-52G Refue

NOW... PSI MICRO-DIODES PRICED THE SAME AS CONVENTIONAL DIODES

Silicon Micro-Diodes (1/50 the size of conventional diodes) are now available at the same price as their larger counterparts. They include the electrical equivalents of several widely used types:

HIGH SPEED MESA COMPUTER DIODES—1N904 • 1N914. GENERAL PURPOSE COMPUTER DIODES—1N643 • 1N658 • 1N663. LOW LEAKAGE SILICON DIODES—1N457 • 1N458 • 1N459...and a new high voltage series to 1.2 kilovolts.

Additionally, Pacific Semiconductors, Inc. has recently introduced a series of Micro-Transistors designed as companion components. These include electrical equivalents of transistor types 2N696 and 2N697.

RELIABILITY ≥ CONVENTIONAL DIODES

These Micro-Diode types meet or exceed all environmental requirements of MIL-S-19500B.

1. MOISTURE RESISTANCE: MIL-STD-202A, method 106A.
2. TEMPERATURE CYCLING: Ten 15-minute cycles—65°C to 200°C.
3. THERMAL SHOCK: MIL-STD-202A, method 107, test condition C (—65°C to 200°C).
4. CONSTANT ACCELERATION: More than 20,000 G.

For details on life testing and reliability curves, write today for "Micro-Diode Reliability Study."

Pacific Semiconductors, Inc.

PSI

A SUBSIDIARY OF THOMPSON RAMO WOOLDRIDGE, INC.
12955 Chadron Avenue, Hawthorne, California

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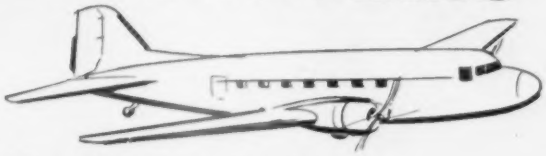
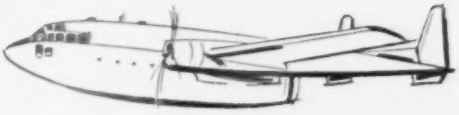


ARE ON MORE



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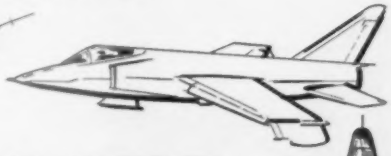

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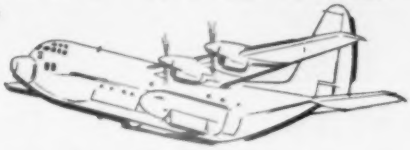
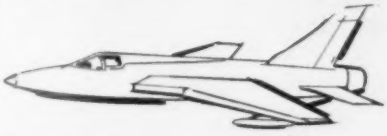


APPLICATIONS

THAN ALL OTHER



8791

MAKES COMBINED

Shown above is partial list of Vickers Aircraft and Missile applications.

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VICKERS INCORPORATED
DETROIT 32, MICHIGAN

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SPERRY RAND CORPORATION

SILICONE NEWS from Dow Corning

Beyond All Others...

Here's Why Silastic Is Used In Man's Probes Into Space!

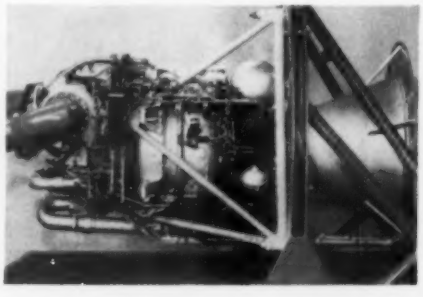
By going faster and farther into space, the X-15 adds to our rapidly expanding knowledge about the chances of men and materials surviving the trip out—*and back*. That's why only proven materials are selected. One of those is Silastic® LS, the Dow Corning fluorosilicone rubber that resists oils, fuels and solvents.

Engineers of Reaction Motors Division of Thiokol Chemical Corporation specified an accumulator diaphragm of Silastic LS for the X-15's XLR-99 engine. The accumulator provides oil at a constant pressure to the lube oil pump. Gaseous nitrogen under pressure is the source of stored energy, and is separated from 4-11V Halocarbon oil by the Silastic LS.

Here are diaphragm requirements the designers established as essential: An elastomer flexible from —80 to 200 F (Silastic LS maintains its flexibility from —80 to 500 F); compatible with the lube oil at low and elevated temperatures (Silastic LS has little swell or change in durometer readings after immersion in many hot oils, fuels and some hydraulic fluids); will not contaminate lube oil (Silastic LS has no plasticizers or additives which can contaminate by leaching).

Silastic LS... the only elastomer to meet all these requirements... helps the X-15 as it knocks on the door to outer space.

Shown below is the XLR-99 rocket engine. The lube oil accumulator is the light weight type... made possible by the diaphragm of Silastic LS... instead of the heavy, bulky piston type. Parts of Silastic can be engineered to meet your specific needs by your rubber fabricator.



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ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D. C.

AVIATION CALENDAR

Aug. 1-3—Fourth Global Communications Symposium, Statler Hilton Hotel, Washington, D. C. Sponsors: Institute of Radio Engineers; U. S. Army Signal Corps.

Aug. 1-3—"Future of Manned Military Aircraft" (Classified Meeting), Institute of the Aeronautical Sciences, El Cortez Hotel, San Diego, Calif.

Aug. 1-4—Annual Technical Symposium and Exhiborama, Society of Photographic Instrumentation Engineers, Ambassador Hotel, Los Angeles, Calif.

Aug. 2-11—27th Annual U. S. National Soaring Championships, Ector County Airport, Odessa, Tex.

Aug. 7-15—Third Annual Institute on Missile and Rocket Technology, University of Connecticut, Storrs, Conn. Cosponsor: U. S. Army chief of R&D.

Aug. 8-11—Western National Meeting, American Astronautical Society, Olympic Hotel, Seattle, Wash.

Aug. 8-12—1960 Pacific General Meeting, American Institute of Electrical Engineers, El Cortez Hotel, San Diego, Calif.

Aug. 14-17—Fourth National Heat Transfer Conference and Exhibit, Statler Hilton Hotel, Buffalo, N. Y. Sponsors: American Institute of Chemical Engineers; American Society of Mechanical Engineers.

Aug. 15-20—11th Annual Congress, International Astronautical Federation, Royal Institute of Technology, Stockholm.

Aug. 16-18—Fourth Annual Tri-Service Conference on Biological Effects of Microwave Radiation, New York University Post-Graduate Medical School, NYU Medical Center, N.Y.C. Sponsor: Air Research and Development Command.

Aug. 18-19—Second International Symposium on Submarine and Space Medicine, Laboratory of Aviation and Naval Medicine, Karolinska Institute, Stockholm.

Aug. 18-19—Electronic Packaging Symposium, University of Colorado, Boulder.

(Continued on page 6)

AVIATION WEEK and Space Technology

July 25, 1960
Vol. 73, No. 4

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Photo courtesy Radio Corporation of America

aerospace

Components for RVX and TIROS Projects by LAVELLE

Major successes in the nation's accelerated space vehicle and missile programs include precision sheet metal components made by Lavelle. Among these is the fabrication by Lavelle of the structure of the new U. S. earth-circling TIROS weather observation satellite produced for the National Aeronautics and Space Administration by the Astro-Electronics Products Division, RCA. An artist's view of TIROS in orbit is shown above.

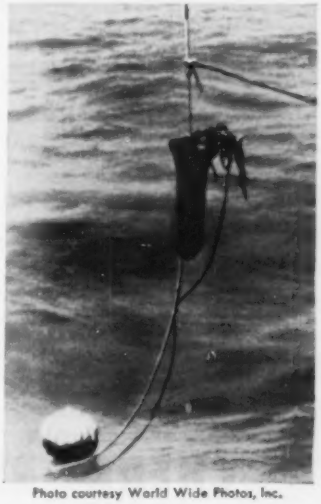

Photo courtesy World Wide Photos, Inc.

Pictured also is the recovery of the first successful RVX series re-entry vehicle after ICBM range flight. The aluminum alloy nose cone structure for this test was fabricated by Lavelle under sub-contract from the General Electric Company's Missile and Space Vehicle Department.

Some of the reasons why Lavelle has been selected to be a part of such dramatic projects are illustrated in a new brochure. Write for your copy.

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Between Philadelphia, Pa., and Trenton, N.J.

No aircraft rivet can match the features offered in the New Cherrylock* "2000" Series rivet.

Proven high sheet clamp-up—one rivet can be used for several material thicknesses, reducing stock requirements and lowering cost. Complete hole fill even in oversize holes, with uniform head seating, wide grip range and mechanically locked stem.

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Available in:

A-286 Stainless Steel
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For technical data on the new Cherrylock "2000" Series rivets, write Cherry Rivet Division, Townsend Company, Box 2157-N, Santa Ana, Calif.

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AVIATION CALENDAR

(Continued from page 5)

Aug. 23-25—1960 Cryogenic Engineering Conference, University of Colorado.

Aug. 23-26—Western Electronic Show & Convention, Los Angeles Memorial Sports Arena, Los Angeles, Calif.

Aug. 28-Sept. 5—1960 National Air Rally, Municipal Airport, Orange, Mass. Sponsor: National Aeronautic Assn.

Sept. 1—Symposium on Rocket and Satellite Instrumentation, Society of Instrument Technology and British Interplanetary Society, London, England.

Sept. 4-5—Civilian, Closed-Course Airplane Races, Lakefront Airport, Cleveland.

Sept. 5-11—1960 Farnborough Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, Eng.

Sept. 7-9—Joint Automatic Control Conference, Massachusetts Institute of Technology, Cambridge, Mass. Sponsors: Instrument Society of America; American Society of Mechanical Engineers; American Institute of Electrical Engineers; Institute of Radio Engineers; American Institute of Chemical Engineers.

Sept. 8-9—1960 Engine and Operations Symposium, Airwork Corp., Millville, N. J.

Sept. 12-16—16th Annual General Meeting, IATA, Copenhagen, Denmark.

Sept. 12-16—Second International Congress, International Council of the Aeronautical Sciences, Zurich, Switzerland.

Sept. 14-16—Annual Meeting, National Assn. of State Aviation Officials, Wort Hotel, Jackson, Wyo.

Sept. 15-16—15th Annual Meeting, Armed Forces Chemical Assn., Sheraton-Park Hotel, Washington, D. C.

Sept. 19-22—National Symposium on Space Electronics and Telemetry, Institute of Radio Engineers, Shoreham Hotel, Washington, D. C.

Sept. 20-22—13th Annual Meeting & Forum, National Business Aircraft Assn., Ambassador Hotel, Los Angeles, Calif.

Sept. 21-25—National Convention and Aerospace Panorama, Air Force Assn., Civic Auditorium and Brooks Hall, San Francisco, Calif.

Sept. 25-27—24th Annual Convention, International Northwest Aviation Council, Harrison Hot Springs, British Columbia.

Sept. 27-30—Space Power Systems Conference, American Rocket Society, Miramar Hotel, Santa Monica. Cosponsors: USAF; U. S. Army; U. S. Navy; NASA; AEC.

Oct. 3-5—Sixth National Communications Symposium, Institute of Radio Engineers, Utica, N. Y.

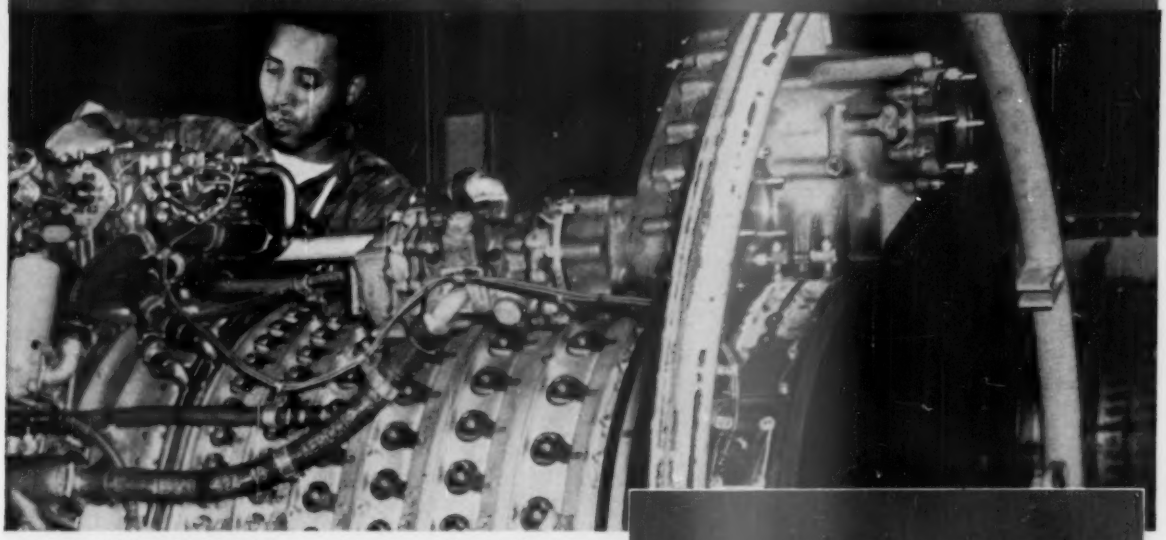
Oct. 3-5—Seventh Annual Meeting, Institute of Radio Engineers' Professional Group on Nuclear Science, Gatlinburg, Tenn. Cosponsor: Oak Ridge National Laboratory.

Oct. 3-5—National Midwestern Conference on Air Logistics, Institute of the Aeronautical Sciences, Tulsa, Okla.

Oct. 3-5—First International Air Traffic Control Conference and Fifth Annual Meeting of the Air Traffic Control Assn., Sheraton-Palace Hotel, San Francisco.

Oct. 10-14—Society of Automotive Engineers National Aeronautic Meeting, Ambassador Hotel, Los Angeles, Calif.

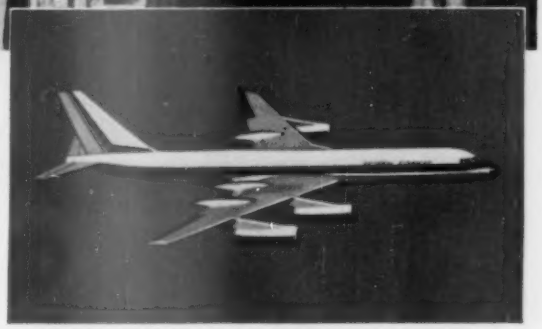
New CJ805-23 Aft-Turbofan Engines Designed With Aeroquip High-Performance Products



Aeroquip 666 Hose of Teflon, 601 Hose and Aeroquip special formed tubing being installed by a General Electric employee on the CJ805-23 during production.

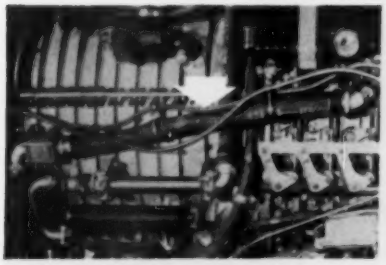
The CJ805-23 aft-turbofan engine represents a new peak in engineering achievement for General Electric. It is designed with the promise of greater fuel economy for commercial airliners in climbing and cruising, plus lower operating costs. High-performance Aeroquip products are specified for use on the fluid system of this new engine.

Aeroquip produces a complete range of fluid line products for top performance in aircraft and missile applications. These extensive product lines plus Aeroquip's engineering experience are available to help you solve any fluid system design and development problem. Mail coupon for complete information.

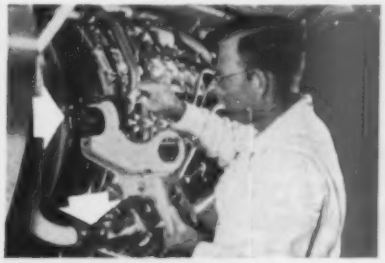


The sleek, new Convair 600, equipped with four General Electric CJ805-23 engines, is now on order by American Airlines, Swissair, SAS and Real.

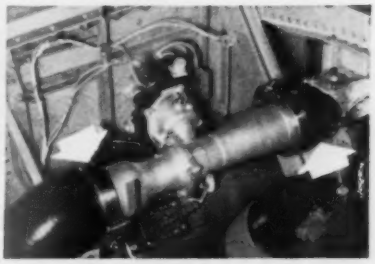
AEROQUIP AND MARMAN PRODUCTS USED ON NEW CJ805-23 AND CONVAIR 600



Aeroquip 666 Hose of Teflon used on the CJ805-23 covered with Aeroquip 624 fire sleeving is rated "fireproof" under FAA standards.



Marman Support Clamps and Structural V-Band Couplings are used on the CJ805-23 engine.



Marman LJ-11 Joints with safety band supports are used on this Convair 600 cabin pressure regulator and on anti-icing and air-start systems.

Aeroquip

AEROQUIP CORPORATION, JACKSON, MICHIGAN
AEROQUIP CORPORATION, WESTERN DIVISION, BURBANK, CALIFORNIA
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Designs are one thing. Deliveries another. Both come from HILLER AIRCRAFT CORPORATION

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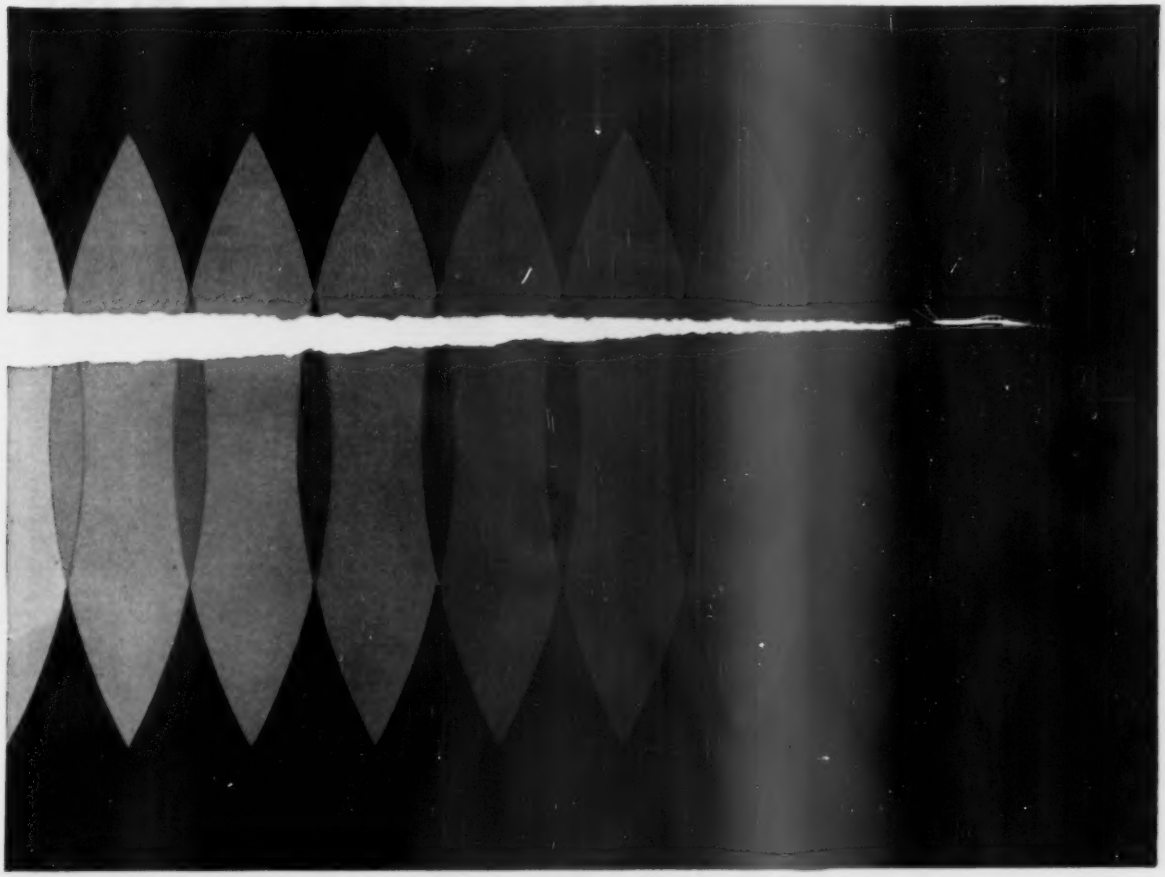
Metallurgical Memo from General Electric



How a super alloy will hit Mach 3 from a vacuum start

Metallurgical Products Department reports on René 41*—and how it combines workability with high strength in high-stress components for jets

When jet-engine and structural component specifications call for the "impossible" – top strength combined with high temperature resistance and minimum weight – a vacuum-induction-melted alloy may be the answer. An outstanding example: René 41!

Made by the General Electric vacuum-induction-melting process, René 41 is virtually free from impurities; can be successfully forged, welded, or formed. With greater tensile and stress rupture strengths, René 41 permits higher operating temperatures and provides increased engine efficiency in jet aircraft. No alloy with comparable mechanical properties can approach the workability of René 41!

Got a design problem? Choose from General Electric's variety of high-purity, vacuum-induction-melted alloys in sheets, bars, billets, wire, or castings. For detailed information – or the assistance of one of our engineers – write today to: *Metallurgical Products Department of General Electric Company, 11107 E. 8 Mile Road, Detroit 32, Michigan.*

**René 41 is a trademark of the General Electric Company*

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CARBOLOY® CEMENTED CARBIDES • MAN-MADE DIAMONDS • MAGNETIC MATERIALS • THERMISTORS • THYRITE® • VACUUM-MELTED ALLOYS

Quaker Thermoid

THE ONLY JET STARTER HOSE GUARANTEED FOR 4500 STARTS

UNIQUE CONSTRUCTION OUTLASTS AND OUTPERFORMS ALL OTHERS

Fittings are provided to fit standard connections on all aircraft and starter trucks. They are easily removed and reassembled in field, yet they safely withstand duct pressures far in excess of burst point.

Duct liner consists of seamless, extruded Silicone rubber for resistance to high heat, up to 500°F, and flexibility at temperatures as low as 65°F.

Scuffer jacket protects hose from abrasion. Loosely fitted sleeve of open mesh Dacron is resistant to mildew, fungus, extreme heat or cold. Spiral scuffer strip of natural rubber is bonded to sleeve. Easily replaceable.

Duct reinforcement is a bonded layer of interwoven Dacron for strength, dimensional stability and resistance to mildew, fungus and extreme temperatures.

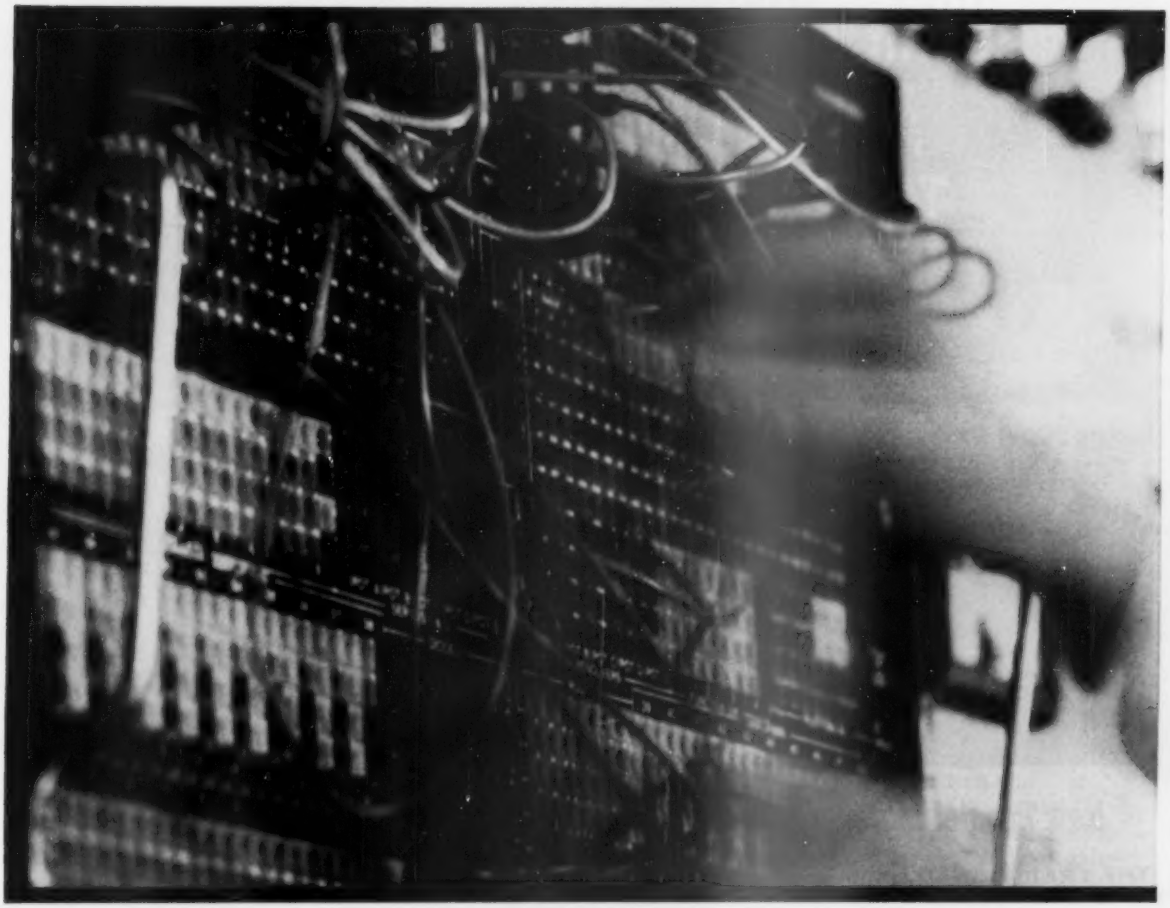
Jet Starter Hose, pioneered and developed by Thermoid Division, is the only hose *guaranteed* to perform satisfactorily for a full year or 4500 starts . . . is the *only starter hose approved by the government* and is the choice of major jet operating airlines the world around. Exhaustive use has demonstrated that Thermoid-Quaker Jet Starter Hose outperforms other hose by more than three to one.

For more information on this outstanding jet starter hose see your Thermoid Division distributor or write *Thermoid Division, H. K. Porter Company, Inc., 200 Whitehead Road, Trenton 6, N.J.*

THERMOID DIVISION PORTER ***H. K. PORTER COMPANY, INC.***

PORTER SERVES INDUSTRY with steel, rubber and friction products, asbestos textiles, high voltage electrical equipment, electrical wire and cable, wiring systems, motors, fans, blowers, specialty alloys, paints, refractories, tools, forgings and pipe fittings, roll formings and stampings, wire rope and strand.

DYSTAC*



A MAJOR BREAKTHROUGH IN PROBLEM SOLVING

*DYSTAC: Dynamic Storage Analog Computer, developed by CSI, incorporates high-speed repetitive capabilities with dynamic storage of analog data to an accuracy of 0.01% and with a time-base accuracy of ±0.5 microsecond. This development has tremendously increased the versatility, economy, and speed of solution associated with analog computers.

DYSTAC provides unique time-sharing of computer components and high speed reiterations. These features make possible economic and rapid solution of complex problems that have required too many computer components or too long a solution time to be considered practical for either digital or analog techniques. Different combinations of this new development readily solve problems in four broad categories.

- Sequential calculation, as encountered in the distillation problem. Here, successive solutions to algebraic matrices are obtained from cycle to cycle at a repetitive speed of 60 cps until the problem is solved.
- Definite integral calculations. Varying definite integrals are evaluated from one cycle to another and held in memory for the successful solution of optimization problems.
- Rapid evaluation of multiple integrals. This technique can be employed for the solution of partial differential equations.
- Transient problems and difference-differential equations are solved with continuous memory.

For complete information or to arrange for a demonstration write, phone, or wire:

COMPUTER SYSTEMS, INC., Culver Road, Monmouth Junction, N. J. • DAvis 9-2351

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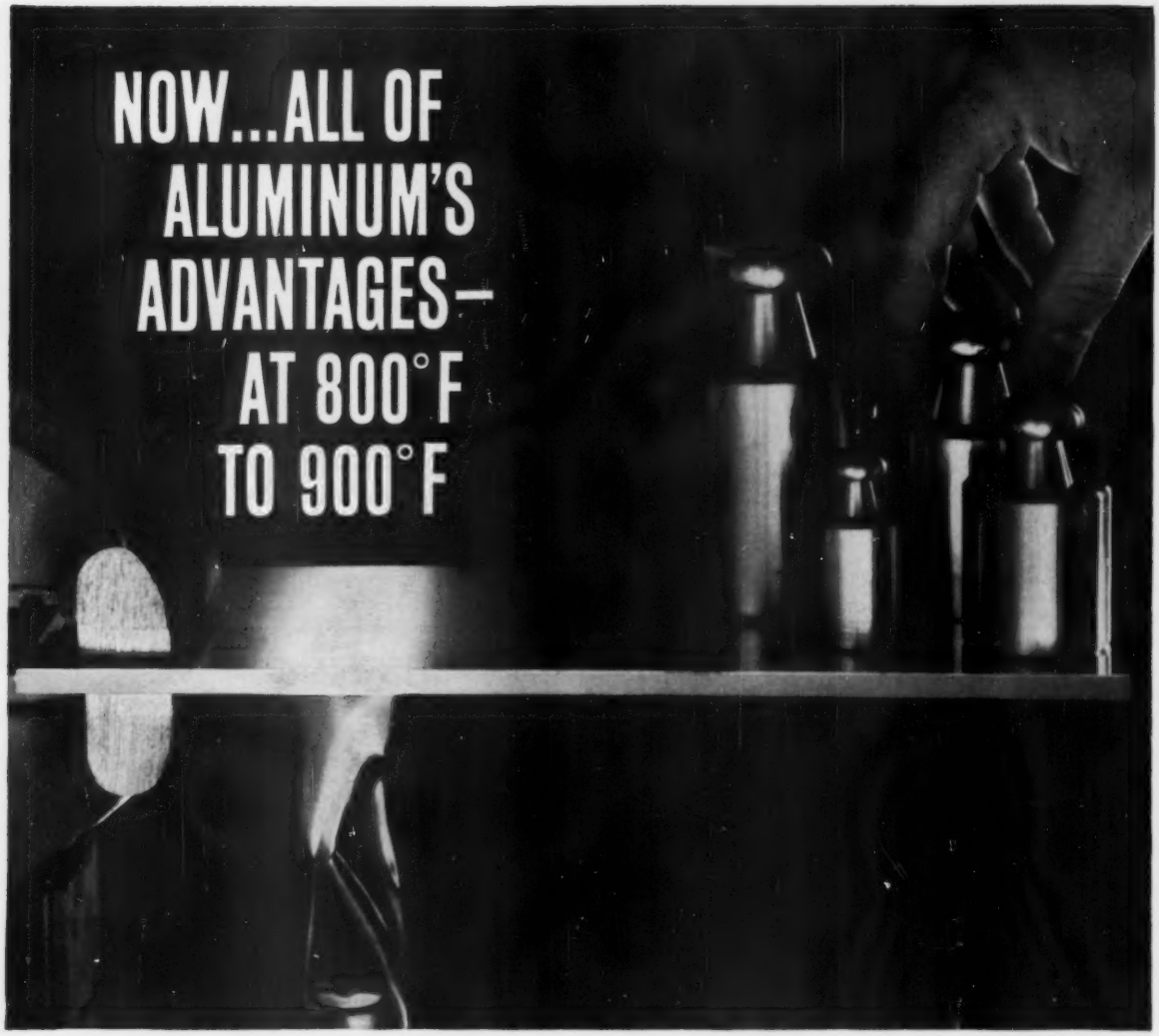


New Powder Metallurgy Products Broaden Aluminum's Defense Applications

THE TRADITIONAL advantages of aluminum—at temperatures up to around 500°F—can now be extended to temperatures hundreds of degrees higher than conventional aluminum can take.

THANKS TO Alcoa's pioneering with the metallurgical technique known as "dispersion hardening," solid aluminum products reformed from *powdered* aluminum by heat and pressure take on new qualities. They are fine-grained, hard, tough, sapphire-like in brilliance, and amazingly resistant to heat effects.

ALUMINUM POWDER metallurgy products—"APMP" for short—are available in a family of four alloys. They are usually extruded into forms which can subsequently be further extruded, rolled, forged, drawn or impacted by conventional metal-working methods. Where you need the properties of aluminum, but where temperatures seem "too high" for conventional aluminum products, chances are that one of these four alloys may solve a host of hectic problems.

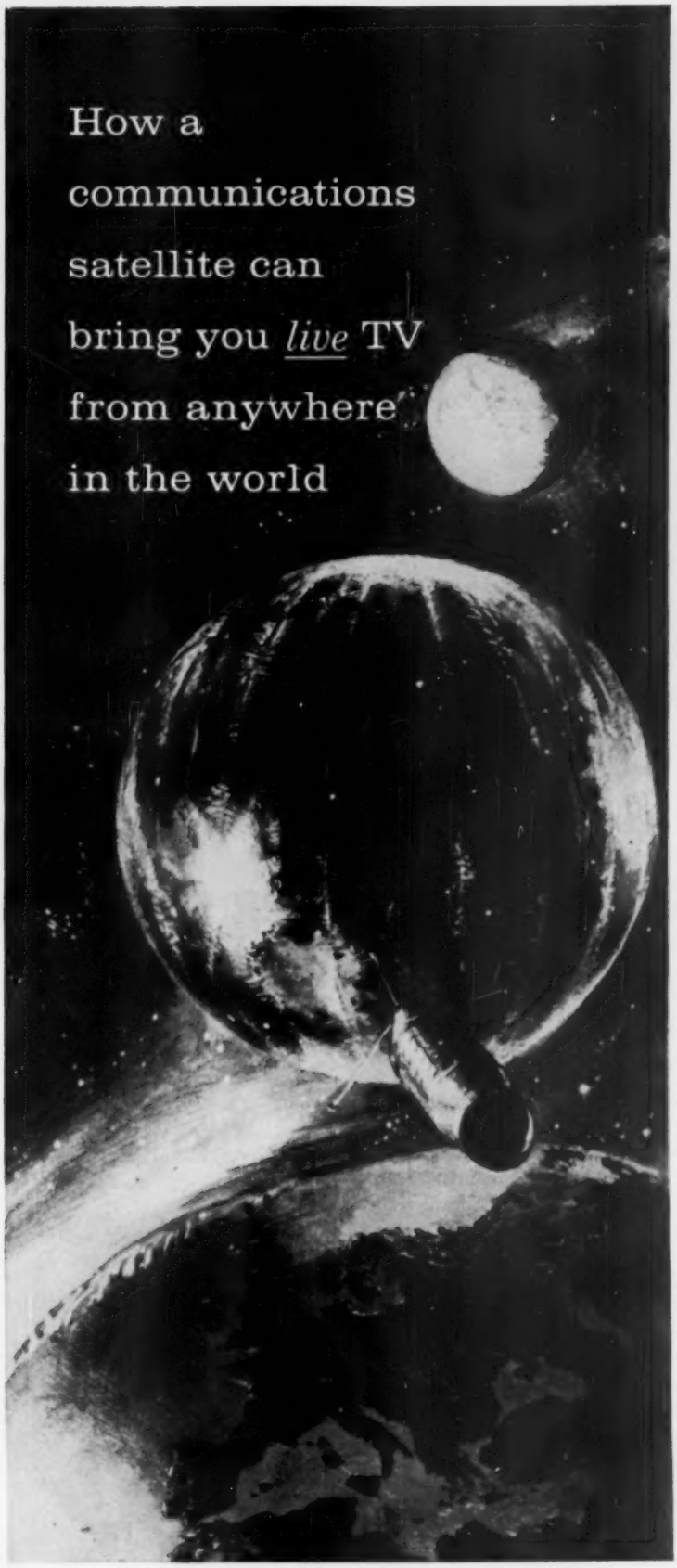
THE SUCCESSFUL development of these new APM alloys suggests what can happen when Alcoa research is applied to defense projects. We always stand ready to take on Research and Development assignments of a similar nature. For more information on APM alloys or Alcoa's R&D capabilities, write: Aluminum Company of America, 2026-U Alcoa Building, Pittsburgh 19, Pa.

For exciting drama watch "Alcoa Presents" every Tuesday, ABC-TV, and "Alcoa Theatre" alternate Mondays, NBC-TV

ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA

How a communications satellite can bring you *live* TV from anywhere in the world



World-wide live TV, with no cable or radio relay costs, can develop from outer-space research by government and industry

Among the peaceful applications for scientific break-throughs being made in the study of outer space is a communications satellite.

Using inflated plastic satellites, boosted toward orbit by the Air Force *Thor* rocket, a global TV network could be established. TV signals would bounce to satellite and back to your station, giving you a front-row seat at events anywhere in the world. Cost should be a fraction of coaxial cables and microwave relays now used.

Practicality of *Thor* for this purpose is based on its demonstrated reliability. With Douglas responsible for airframe fabrication and assembly and test of the entire system, *Thor* has helped launch 84% of all payload weight put into space by the U. S.; is the key booster in the Air Force "Discoverer" firings; launched the first nose cone recovered at ICBM range.

Thor is another product of the imagination, experience and skills which Douglas has gained in nearly 20 years of missile development.

Foil-covered satellite, folded like a pocket raincoat, would balloon out in orbit as an inexpensive TV relay station

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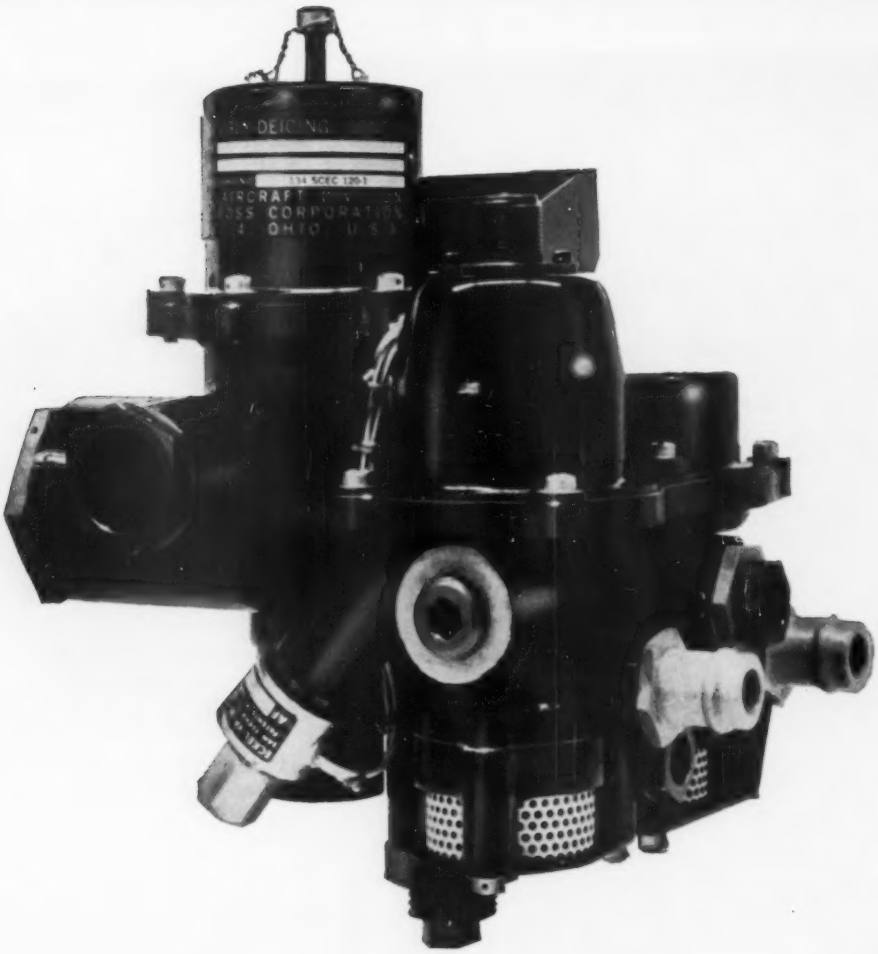

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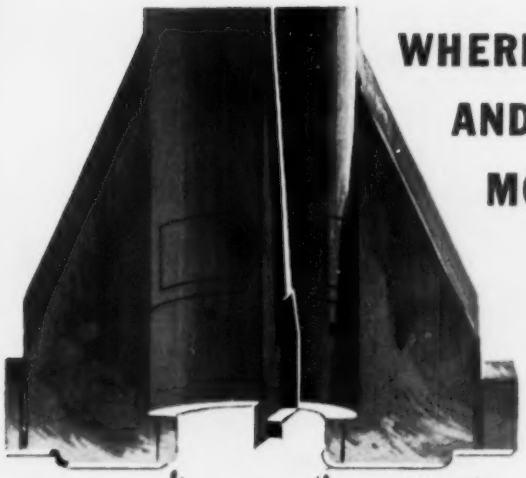

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	Midvac	117,000 psi.	150,500 psi.	21.3%	33.8%
Gannalloy	Air Melt	112,000	159,900	13.0%	21.0%
	Midvac	142,600	177,250	18.0%	31.6%
D6A-C	Air Melt	234,800	281,000	4.9%	20.6%
	Midvac	256,700	294,250	9.6%	28.4%
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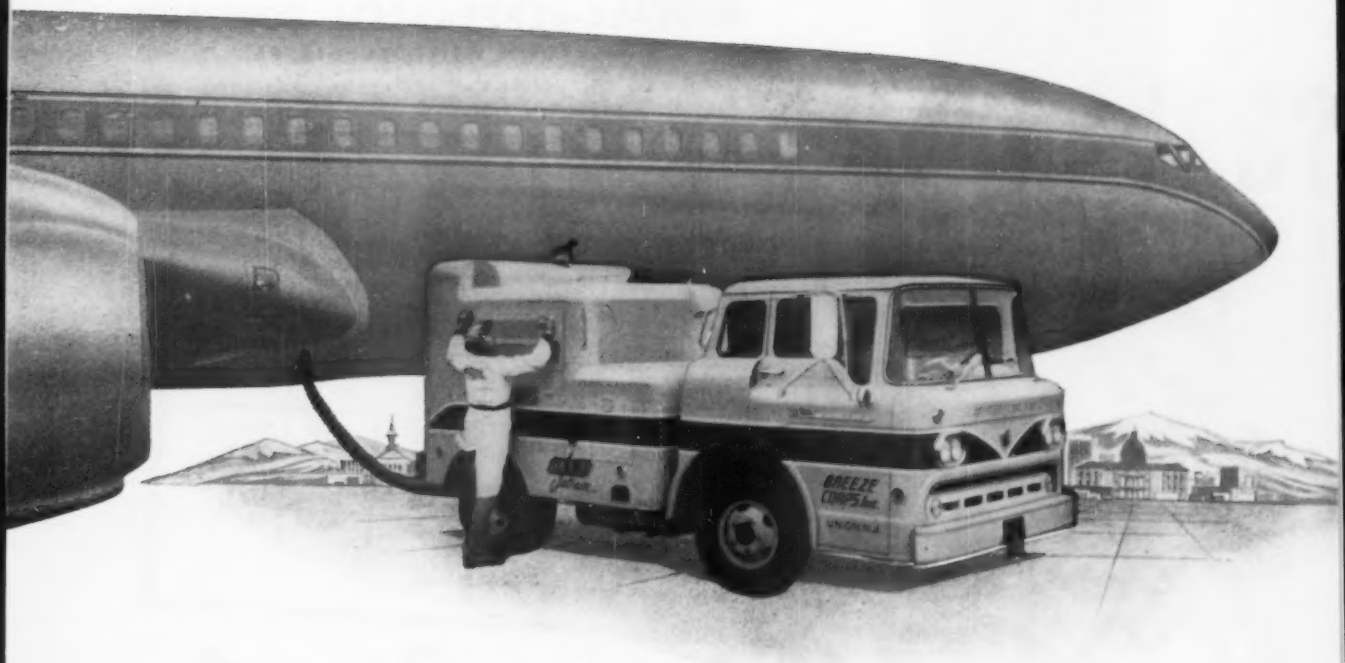

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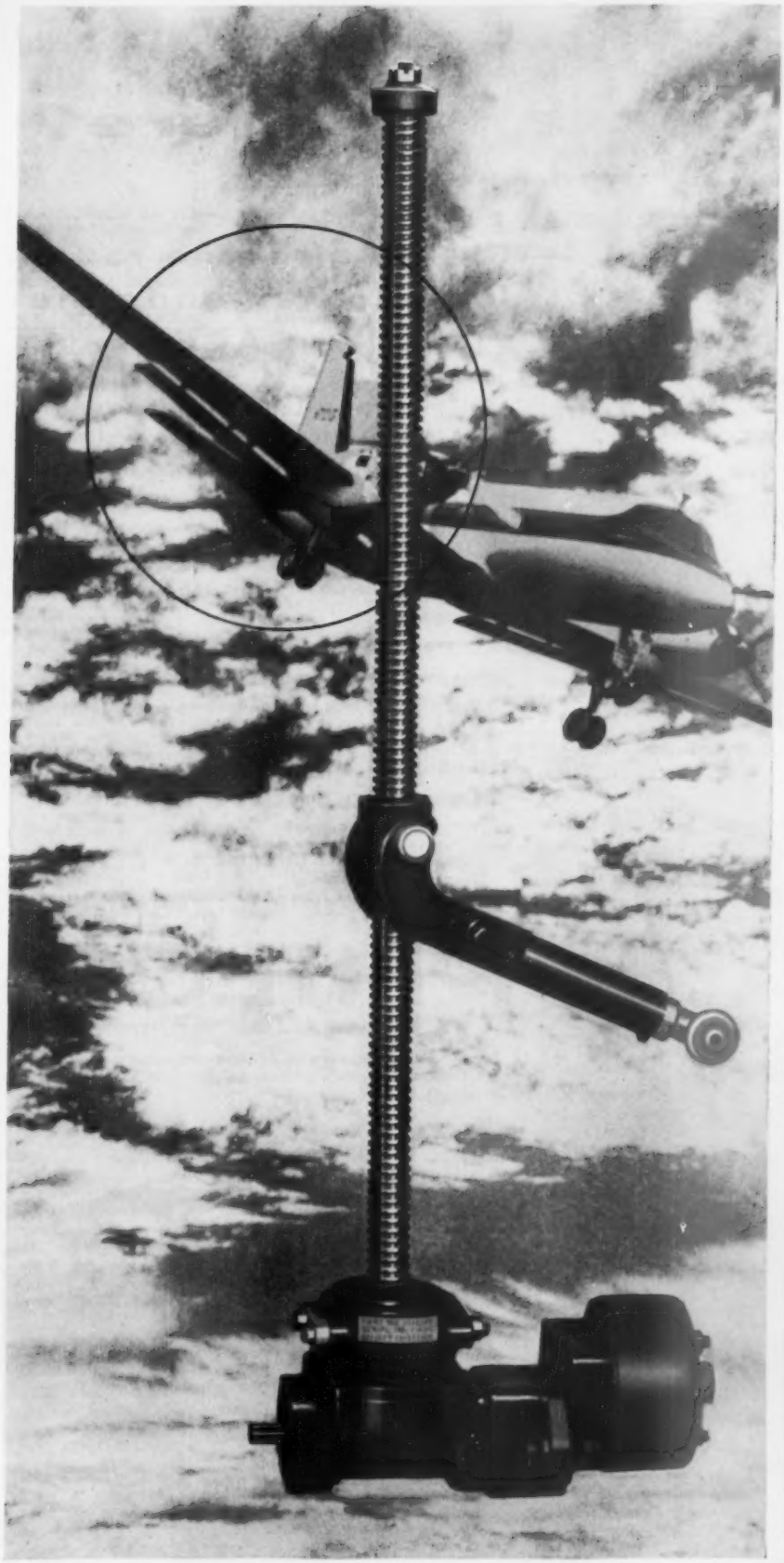

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COVER: Boeing B-52G has 15% greater non-refuel range than previous models as a result of major structural redesign which reduced aircraft weight by 10,000 lb. KC-135 boom is extended and retracted by a left hand control; right hand control stick enables boom operator to fly it up or down and to either side. V-shaped ruddevator on boom provides control. Note Hound Dog missiles located under the B-52 wing.

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8	M	400	6	33CT	8M62A	8M62B
8	MG	400	6	26S	8MG61A	8MG61B
8	MG	400	6	33CT	8MG62A	8MG62B
9	M	400	4	26P	9M40A	9M40B
9	M	400	4	26S	9M41A	9M41B
9	M	400	4	26S	9M61A	9M61B
9	MG	400	4	26S	9MG41A	9MG41B
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115 VOLT FIXED WINDING AND GENERATOR OUTPUT

					PLAIN SHAFT ½" x .1200"	HOBBED SHAFT 13T x 120P
11	M	60	2	115CT	11M25A	11M25B
11	M	60	2	115P	11M24A	11M24B
11	M	400	6	115S	11M66A	11M66B
11	M	400	6	36CT	11M63A	11M63B
11	MG	400	6	115S	11MG66A	11MG66B
11	MG	400	6	36CT	11MG63A	11MG63B
					PLAIN SHAFT ⅝" x .1870"	HOBBED SHAFT 15T x 96P
15	M	60	2	230S	15M27C	15M27D
15	M	400	4	115S	15M46C	15M46D
15	M	400	4	36CT	15M43C	15M43D
15	M	400	8	115S	15M86C	15M86D
15	M	400	8	36CT	15M83C	15M83D
15	MG	60	2	230S	15MG27C	15MG27D
15	MG	400	4	115S	15MG46C	15MG46D
15	MG	400	4	36CT	15MG43C	15MG43D
15	MG	400	8	115S	15MG86C	15MG86D
15	MG	400	8	36CT	15MG83C	15MG83D
18	M	60	2	230S	18M28C	18M28D
48	M	400	4	115S	18M46C	18M46D
18	M	400	4	36CT	18M43C	18M43D
18	M	400	8	115S	18M86C	18M86D
18	M	400	8	36CT	18M83C	18M83D
18	MG	60	2	230S	18MG28C	18MG28D
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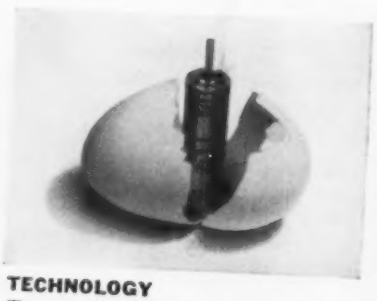

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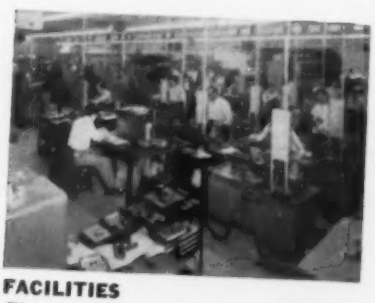

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EDITORIAL

Satellite Blackmail

Last week we predicted that the next technical advance the Soviets would incorporate into their international diplomatic blackmail program would be the use of satellites. This is a subject worth exploring further. AVIATION WEEK's Avionics Editor Philip Klass earlier (AW July 11, p. 26) presented an exclusive report on Defense Department studies of the potential of nuclear-armed bombardment satellites (NABS) which should serve as a useful technical foundation for any discussion of the application of space technology to the pattern of diplomatic blackmail.

Although the technical problems in delivering a nuclear bombardment payload from an orbiting satellite to a precise spot on the earth are still formidable, the basic technology of putting payloads into orbit heavy enough to accommodate the largest nuclear weapons and of re-entering them into the atmosphere has been proved by the Soviet Sputniks and our own ICBM tests. Like most modern weapons, any bombardment satellite would be more useful as a threat either to deter undesired action or to force compliance with some international gambit than it would be when actually hurled at a target to destroy it. This has been one of the fundamental changes in the use of military weapons in the nuclear age and its basic strategy of deterrence.

Satellites' Effect

It would be hard to calculate precisely now what the effect would be of the sudden appearance of a half dozen ominously black satellites passing over the United States every 90 min. coupled with a Soviet announcement that they contained "fantastic new nuclear weapons" capable of being re-entered precisely on predetermined targets. If this event occurred in the near future, the panic might be considerable since we have no capability of either determining the genuine contents of a satellite or shooting it out of orbit. It would be possible for the Soviets to run a considerable bluff for some time even if the satellites contained nothing more lethal than old copies of Pravda. Any such interval could be used as cover for another key move on the international chessboard.

Sooner or later, the entire problem of the rights of nations to orbit satellites over territories of other nations is going to become a thorny international wrangle. The relatively harmless scientific nature of the early Sputniks, Vanguards and Explorers made it easy to ignore temporarily this question of space sovereignty. But with the appearance of an operational capability for reconnaissance provided by the Midas, Samos and Tiros projects, this question is certain to become a burning issue. We suspect the Soviets are working hard now to develop an operational anti-satellite capability that will be ready for use when the first operational web of Midas satellites are shot into orbit.

This country should be strenuously engaged in a similar type of program. There have been some initial explorations of the anti-satellite problem with a few air-launched ballistic missile shots at an Explorer and with studies of satellite interceptors under the USAF Project Saint. However, these efforts are still relatively puny, and initial attempts to build them into solid programs with good priority have run into the fiscal straitjacket imposed by the Budget Bureau and top levels of the Defense Department.

Basic Approaches

There are two basic approaches to an anti-satellite capability: the first and easier method, aimed at knocking a satellite out of orbit after its orbit has been stabilized and calculated; and the second, a much more difficult technical task, to catch it on the rise into orbit or on its first pass approaching the territory to be protected. Some people studying the problem believe it can best be solved by a ground-based missile system tied into a space age SAGE computer complex, while others believe the most effective method is the development of manned space vehicles armed with anti-satellite weapons and a capability to inspect dubious orbiters and possibly repair defective systems in our own military satellite systems.

Whatever the approaches taken, it is evident that development of an anti-satellite capability now in time to be useful against the appearance of any foreign devices is a matter of primary national interest. It will serve little purpose to wait until the "black" satellites appear over our populous cities and then push a "crash" program for anti-satellite weapons. Unless this capability already exists when the Soviets attempt such a gambit, it is apt to be successful for the time period they require. If our anti-satellite capability is developed and successfully demonstrated, we may never have to face the problem of how to cope with satellite blackmail, and we may avoid a chapter of dangerous potential in our relations with the forces of Communist imperialism.

Investment Dividends

Developing an anti-satellite capability would be expensive, as is any new technical venture. But if it denied any potential enemy the opportunity to embark on satellite blackmail once the opportunities for ballistic missile blackmail have passed, it would indeed be an investment that offered tremendous dividends. Nor should the purely technical liabilities of a nuclear-armed bombardment satellite be allowed to obscure the psychological potential of such a weapon if it suddenly appeared in space with no effective counter-weapon then available on earth.

We respectfully suggest that this is an area that deserves considerably more attention than it is now receiving and that both presidential candidates and their defense advisers explore it thoroughly as one of the high priority items they should consider adding to our weapons spectrum when one of them assumes responsibility for the defense of this country and its position of international leadership in the world next January.

—Robert Hotz

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WHO'S WHERE

In the Front Office

E. Clinton Towl, president, Grumman Aircraft Engineering Corp., Bethpage, N. Y., succeeding the late **Leon A. Swirbul.** Also: **William T. Schwendler**, chairman of the executive committee, and **Llewellyn J. Evans**, a vice president.

Harold Huleguard, president, Mertronics Corp., Santa Monica, Calif. Mr. Huleguard continues as president of Gray and Huleguard, Inc., a subsidiary. Also: **Frederick W. Hornbruch, Jr.**, board chairman of Mertronics, succeeding **Adm. Alan G. Kirk** (USN, ret.) who is now chairman of the finance committee on Titeflex, Inc., Springfield, Mass.

Royal Little, president, Textron Electronics, New York, N. Y., succeeding **George W. Miller**, now president and chief administrative officer of Textron, Inc. Also: **Joseph B. Collinson**, vice president and treasurer, and **Charles K. Mills**, vice president and assistant to the president of Textron Electronics.

Frank E. Hedrick, executive vice president, Beech Aircraft Corp., Wichita, Kan., and **James N. Lew**, vice president-engineering.

Edward J. Quemer, vice president and general manager, Transicoil Division of Daystrom, Inc., Worcester, Pa.

Bernard R. Garrett, vice president-engineering and research, Loral Electronics Corp., New York, N. Y.

Thomas C. Clark, a vice president, Houston Fearless Corp., Los Angeles, Calif. Mr. Clark continues as general manager of the company's Houston Fearless Division.

Perry R. Rochm, vice president, The Barden Corp., Danbury, Conn.

Thomas J. Carroll, vice president in charge of new products, Semimetals, Inc., Richmond Hill, N. Y.

W. L. Landers has resigned as vice president-operations of Fairchild Engine & Airplane Corp., Hagerstown, Md.

Roy L. Strong, assistant to the president, Piasecki Aircraft Corp., Philadelphia, Pa.

Robert C. Seamans, Jr., associate administrator of the National Aeronautics and Space Administration, Washington, D. C. NASA's Marshall Space Flight Center, Huntsville, Ala., has announced the following appointments: **Cmdr. Bart J. Slattery, Jr.**, director of public information; **Foster Haley**, deputy director of information; **Joe M. Jones**, news chief; **Erich W. Neubert**, associate deputy director for research and development. **Dieter Grau** replaces Mr. Neubert as director of the Center's Systems Analysis and Reliability Division. Also: **Hermann Kroeger**, deputy director of the Center's Guidance and Control Division.

Lt. Col. Glenn Crane, project officer in charge of the Army's Nike Zeus anti-missile missile program, Redstone Arsenal, Ala.

Honors and Elections

John E. Sorenson, a meteorologist for United Air Lines, has been awarded the Edgar S. Gorrell award for an "outstanding contribution toward the improvement of weather analysis and weather forecasting."

(Continued on page 124)

INDUSTRY OBSERVER

► North American Aviation has received an Air Force contract to study problems related to installing nuclear engines in the B-70 airframe. One objective is to determine what subsystems would need modification to operate in the radiation environment.

► **Contract award is expected shortly for over-all operational services for Jet Propulsion Laboratory's Goldstone, Calif., tracking facility. Some dozen firms, including Westinghouse, General Electric, International Telephone and Telegraph, Hughes and Coleman Engineering, have bid. Facility's 10 kw. transmitter is to be boosted to 100 kw. within a year, and a 1,000 kw. installation is being considered.**

► Union Carbide, second largest U.S. chemical company, is now taking an active interest in rocket propulsion work. Dollar-a-year government contract gives it access to classified work in this field. Firm's research institute believes it can offer improvements in storables, high-energy propellants, and solid propellants superior to polyurethane and polybutadiene-acrylic acid types of materials now in use.

► **British Ministry of Aviation has ordered 30 more Folland Gnat turbojet trainers after adopting the tandem seat aircraft as Royal Air Force's standard advanced trainer. Five of the 14 aircraft ordered for evaluation have been flown. Gnat, powered by the 4,230-lb.-thrust Mark 100 Bristol Siddeley Orpheus engine, replaces the de Havilland Vampire T.11.**

► SEPR, French rocket company, is negotiating an agreement for solid rocket work with Thiokol Chemical Corp. believed to be similar in nature to the technical-commercial agreement for liquid rockets recently signed by SEPR and Rocketdyne (see p. 63). Until now SEPR, which is owned by two aircraft and four chemical companies, has left the solid propellant field to state-owned Service des Poudres.

► **Cost argument prepared by Strategic Air Command to show desirability of the B-70 weapon system estimates that a fleet of these bombers would cost the U.S. $10 billion, but would force the Soviet Union to spend $40 billion to strengthen its air defense system.**

► Marquardt is pushing development of hybrid rocket for ballistic missile boosters. Grand Central now provides Marquardt with solid propellant grain for this work but may get direct competition from other companies, including Hercules Powder.

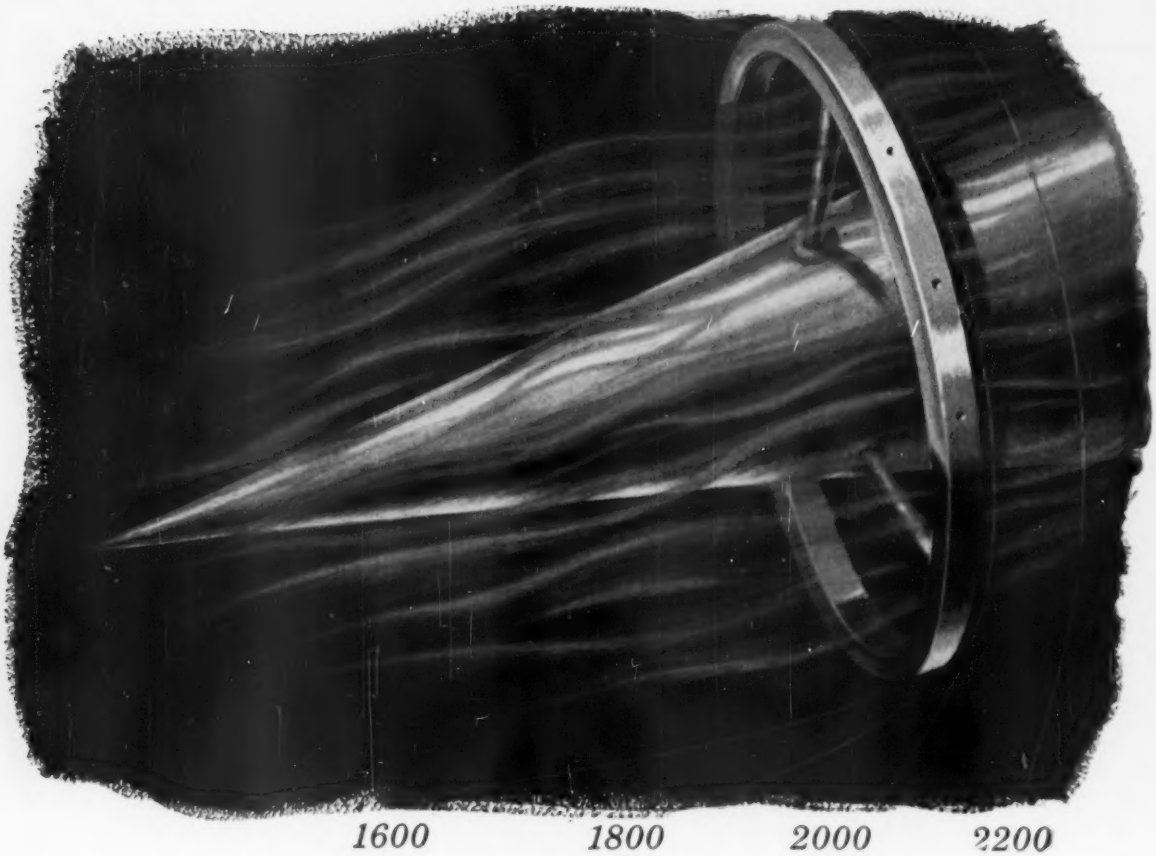
► **Thirty-foot-long bomb bay of the North American B-70 bomber can accommodate largest nuclear weapons existing or now planned. Bomb bay also can carry a wide variety of smaller nuclear weapons, making possible attack on more than 30 targets on a single mission. Multi-mission capability is being provided through development of electronic countermeasures and reconnaissance pods. Bomb bay can carry six pods at once, some of them manned.**

► Hercules Powder Co. expects to sell Thiokol reinforced plastic rocket cases for Minuteman missile first stage. Production price is estimated at $25,000 each, or approximately half the cost quoted for metal cases.

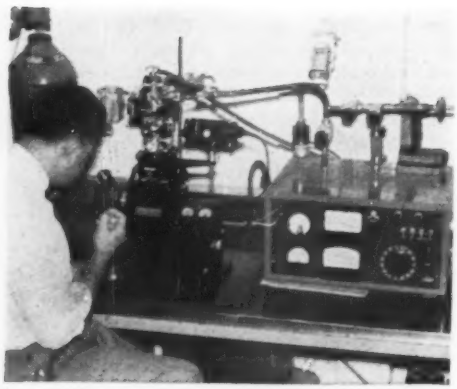
► **Britain's Avro Blue Steel standoff bomb is scheduled to undergo powered flight trials next month, traveling full range with a dummy warhead. Unpowered drop trials have been carried out. Bombs under test now are Mark 1. Britain's Mark 2 V-bombers will carry the Mark 1A Blue Steel, with increased range and improved guidance systems.**

► Development engineering inspection of Minuteman intercontinental ballistic missile system is under way at Boeing Airplane Co.

► **Rocket-firing Soviet research ship Shokalsky (AW July 18, p. 23) was scheduled for a Pacific cruise after firing five meteorological rockets on its Black Sea shakedown cruise. Rockets reach 50 mi. altitude, study pressure, temperature and solar radiation effects.**



Cutting back the Thermal Thicket



Solving high-temperature problems through research is part of Haynes Stellite's complete metallurgical services. This metallograph is used to observe metals at 2200 deg. F.

The great strength and high scaling resistance of HAYNES alloys at temperatures of 2000+ deg. F. are providing long service life in the hottest areas of jet engines. Flame holders, flame steps and afterburners are some of the hot spots where the properties of HAYNES high-temperature alloys are helping combat burnout, erosion, and stress in the jet, ramjet, missile, and rocket fields.

There are twelve HAYNES high-temperature alloys to choose from, formulated to handle virtually any heat condition. Among them: HASTELLOY alloy X with remarkable resistance to oxidation up to 2200 deg. F. HAYNES alloy No. 25 that resists stresses, oxidation, and carburization up to 2000 deg. F. And HASTELLOY alloy R-235, outstanding in the 1500 to 1750 deg. F. range. All are readily available.

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Washington Roundup

Kennedy Defense Plans

Democratic presidential nominee Sen. John F. Kennedy may push for more defense money during the August session of Congress, even though the Fiscal 1961 defense bill already has been completed. If Kennedy were elected, this would provide the funds for him to expand the defense effort quickly in January.

Kennedy will meet with top advisers this week to discuss defense and other issues he may want to develop during the August session. The Democratic nominee favors increasing the defense budget $2-3 billion a year, and some of this increase could be voted next month.

National Aeronautics and Space Administration will brief industry this week on future needs in all its major areas. Industry is expected to send 1,200 to 1,500 representatives to the July 28-29 sessions, which NASA headquarters is running on an invitation-only basis.

Briefings will cover subjects ranging from advanced research to the practical question on how to do business with NASA. Advanced research discussion will cover general problems plus aerodynamics, flight mechanics, space propulsion systems, power generation and structures and materials. Launch vehicle session will cover current vehicles, Saturn advanced vehicles and nuclear units. Space research, satellite programs, lunar and planetary probes and manned space flight also will be discussed.

Higher than anticipated spending for military and space programs in the last six months failed to keep the federal budget from registering a surplus for Fiscal 1960. Defense Department spent $255 million and NASA spent $76 million more during the year than was estimated in January. But reductions in other areas pared $1 billion from total spending estimates and produced a $1,068,000,000 surplus.

Seamans Joins NASA

Dr. Robert C. Seamans, Jr., will take over a management office that grew significantly in its first year of operation when he becomes associate administrator of NASA on Sept. 1. The office has grown from two men on June 1, 1959, to the present force of 16 professionals and seven secretaries.

Richard E. Horner has held this number three job in the space agency, essentially a general manager's post, since it was created a year ago. He is leaving to join Northrop Corp.

Seamans is chief engineer of Radio Corporation of America's Missile Electronics and Controls Division and has been with RCA since 1955. He held teaching and project manager positions for 14 years at Massachusetts Institute of Technology, heading its Flight Control Laboratory from 1953 to 1955. Seamans served on National Advisory Committee for Aeronautics technical committees from 1948 to 1958 and is a member of USAF's Scientific Advisory Board.

Special House Appropriations Subcommittee established to study the Aircraft Nuclear Propulsion program has been dissolved. This group, comprised of members of regular subcommittees on public works and defense, was formed when the public works subcommittee cut $75 million from the atomic energy budget for the ANP project. Appropriations committee later restored the funds, taking the steam out of the study.

Now the issue is whether a Defense Department ANP study due Oct. 1 will be handled by the Defense or the public works group. Rep. Melvin Price, chairman of the Joint Atomic Energy Research and Development Subcommittee, has discounted reports that this Defense study will recommend cancellation of either the General Electric direct cycle engine project or the Pratt & Whitney indirect cycle approach.

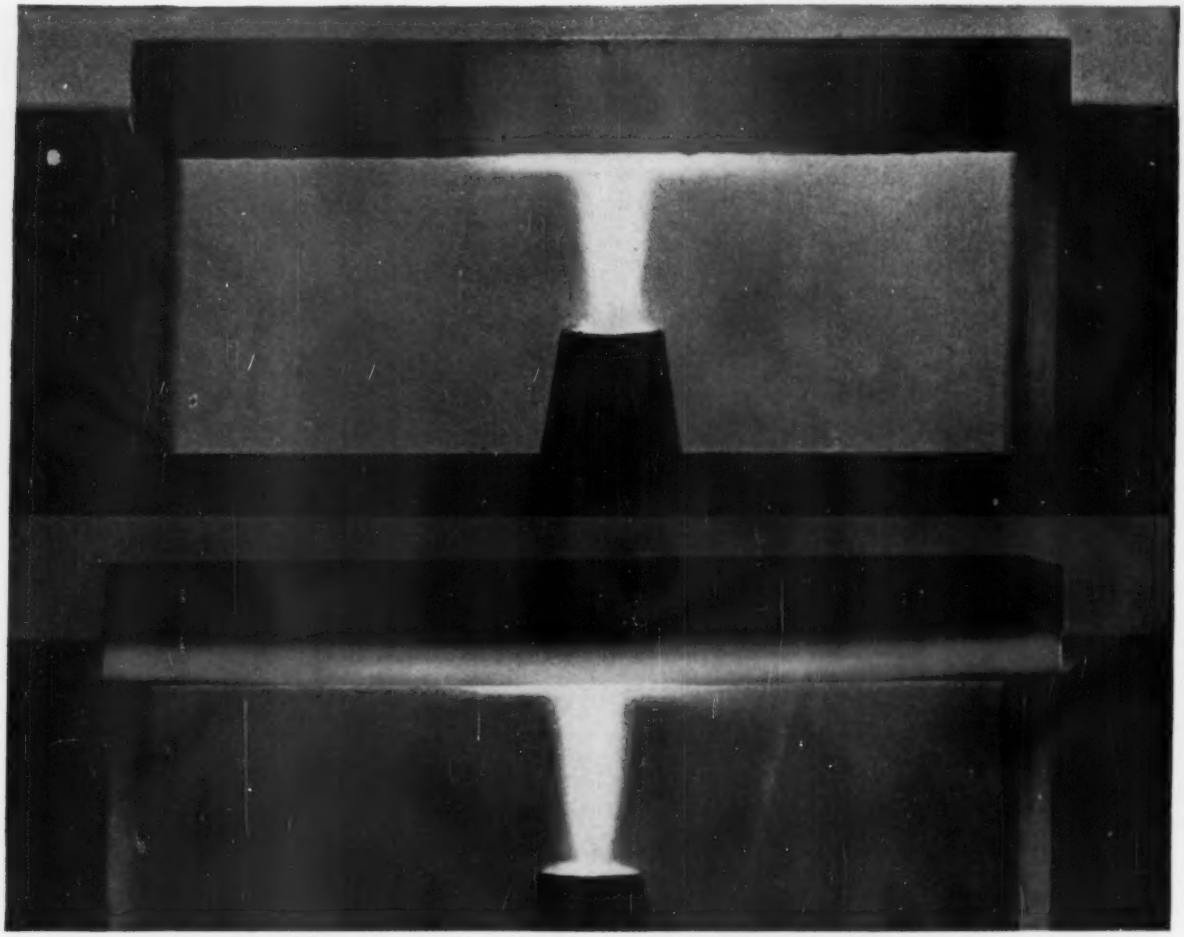
Manned Aircraft Hopes

Defense Department and industry hope to get some firm answers on the future of manned aircraft and the future course of the industry's technical activity next week. Industry hopes to get a line on how much aircraft work will be available and what type it will be. Pentagon wants some realistic estimates of what such advanced aircraft work will cost.

Entire range of manned vehicles from subsonic VTOLS to Dyna-Soar will be reviewed at a joint Department of Defense-Institute of the Aerospace Sciences conference. It will be held in San Diego Aug. 1-3. One prime topic will be Mach 6-10 hypersonic aircraft with a range of a fourth of the earth's circumference. Many consider this a necessary link between the X-15 and Dyna-Soar.

Conference will tackle the basic question when John Rubel, deputy director of defense research and engineering, discusses the economic climate for manned aircraft. Rubel will tie the economic problem to requirements for fighting different types of war.

Services are expected to present a detailed review of future aircraft requirements as they now see them. NASA will discuss technical means available now and expected to be available to meet military requirements. Industry will estimate what can be accomplished with manned aircraft in the coming years. **—Washington Staff**



HEAT from oxygen-acetylene torch flows through 0.25-in. thick slab of commercial graphite (top), while in 0.25-in. slab of pyrolytic graphite produced by High Temperature Materials, Inc., (bottom) it is distributed along layer planes.

Pyrolytic Graphite Studied for Re-Entry

Radiation heat shielding technique may save weight and improve re-entry velocities and accuracies.

By Michael Yaffee

Extensive development work now under way on new graphite materials and structures may soon lead to radically new ballistic missile re-entry vehicles and rocket nozzles which work principally through radiation rather than ablation or heat storage.

New radiation heat shielding technique could lead to significant savings in weight and improvements in re-entry velocities and accuracies. One scientist estimates that new graphite re-entry structures will weigh only one-tenth as much as newest ablation re-entry vehicles (AW July 18, p. 54), will come in on target one-third faster, and will also be more accurate. In rocket nozzles and blast tubes, new materials reportedly will also permit sizable savings in weight as well as the use of high energy propellants with high combustion temperatures and high metal content.

Currently, most interest is centered on pyrolytic graphite (AW Dec. 7, p. 99), a highly oriented crystalline material. First major applications of this material are expected to be in the rocket nozzles and re-entry vehicle of an improved 1,500 mi. Polaris intermediate range ballistic missile.

Navy Special Projects Office, principal military sponsor of research and development on pyrolytic graphite, now is in the process of establishing engineering evaluation programs for pyrolytic graphite material and structures with Lockheed (re-entry vehicles) and Aerojet (nozzles). First flight test of a pyrolytic graphite nozzle will probably take place on a Polaris AX-2 test vehicle (later and more sophisticated version of current AX-1 test vehicle) in about 10 months. First flight test of PG re-entry structure will be somewhat later.

Navy scientists are generally highly enthusiastic about pyrolytic graphite and pyrolytic graphite-based materials. Results of research sponsored by the Special Projects Office over the past two years, a Navy officer says, now justify full scale development of the material for ballistic missile applications.

Air Force is interested in graphite generally for high temperature applications but is more reserved about pyrolytic graphite in particular. Last month, Air Research and Development Command awarded National Carbon Co., a division of Union Carbide, a three-year $12-million contract for research and development of graphite for missile

and space vehicle components. Both Air Force and National Carbon feel it is too early to choose any one form of graphite such as pyrolytic in preference to another such as graphite cloth.

At the same time, it is not inconceivable that pyrolytic graphite will find its way into Air Force's Minuteman ICBM. All three Minuteman motor contractors —Thiokol, Aerojet and Hercules—are known to have contracts out for work on pyrolytic graphite nozzles. It is also conceivable, but less likely, that pyrolytic graphite will find its way into an advanced Minuteman re-entry vehicle. Other possible applications for pyrolytic graphite are in lightweight, reusable heat shields for manned re-entry vehicles such as the Project Mercury capsule and in leading edge structures.

Three principal Navy contractors working on research and development of pyrolytic graphite are General Electric, High Temperature Materials, Inc., and Raytheon. In addition to the Navy's Special Projects Office, these companies are doing pyrolytic graphite work for Aerojet, Arde-Portland, Corning Glass, Douglas, Hercules, Jet Propulsion Laboratory, Lockheed, Rocketdyne and Thiokol.

Besides straight pyrolytic graphite, the Navy contractors are working on alloys of pyrolytic graphite and metals, pyrolytic graphite fibers and coatings. At least one company, High Temperature Materials, is experimenting with the application of pyrolytic graphite processing techniques to another high temperature material, boron nitride. Boron nitride has a crystal structure similar to that of graphite and at the same time is more oxidation resistant.

Oriented Graphite

Pyrolytic graphite is essentially a highly oriented graphite. Compared with commercial graphite which may reach an orientation ratio of 3-to-1 (that is, three crystals with their "c" axes oriented perpendicular to the surface for every one crystal oriented parallel to the surface), pyrolytic graphite may have orientation ratios from 100-to-1 to 1,000-to-1.

For the missile man, the attraction of pyrolytic graphite derives principally from its high thermal anistropy, that is, its ability to conduct heat readily in one direction and block it in another. Thermal conductivity of pyrolytic graphite will run 50 to 1,000 times higher in a direction parallel to the surface, says a High Temperature Materials scientist, than in a direction perpendicular to the surface. At the same time, the material retains the high sublimation temperature of regular graphite, approximately 6,600F.

Electrical anistropy of pyrolytic graphite is even higher than the thermal making it impossible to transmit through a PG re-entry vehicle the microwave signals that would be required for data acquisition or arming. To get around this problem, HTM has developed a device which it says can achieve close to 100% transmission efficiency and requires an electrical "window" only ¼-in. in diameter in the re-entry vehicle. Windows in beryllium re-entry vehicles are believed to be much larger, constituting a more potentially dangerous structural-thermal weak spot in the vehicle. New HTM device is said to work as well with beryllium and other metals as with pyrolytic graphite.

In addition to improved density and high temperature tensile strength, pyrolytic graphite is credited by its proponents with having overcome many of the drawbacks such as poor oxidation and erosion resistances that caused missile men to turn from graphite as a re-entry material (AW May 12, 1958, p. 52). But more perhaps than any other single factor, it is pyrolytic graphite's unusual combination of high sublimation temperature and high thermal anistropy that accounts for the favorable consideration currently being given to the material.

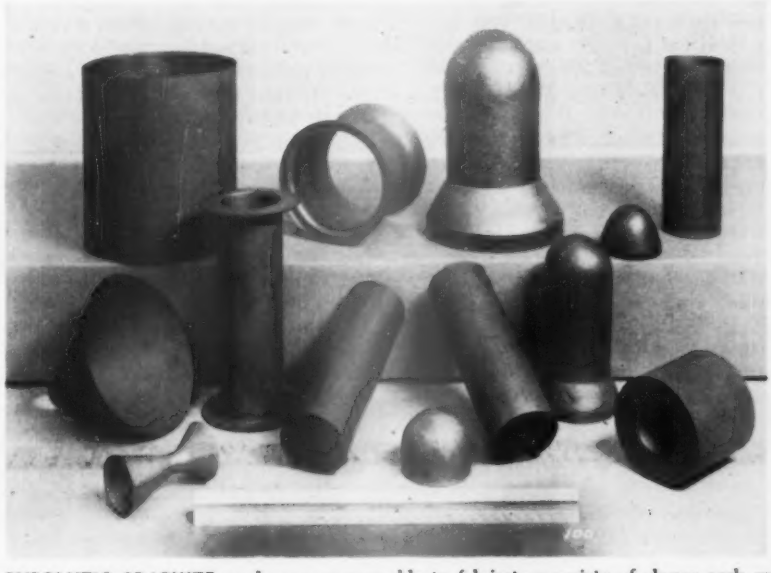
Up until now, radiation heat transfer generally has been considered a comparatively unimportant factor in re-entry heating. The important phenomenon has been aerodynamic heat transfer. But both types of heat transfer vary with altitude (density), velocity and dimensions of the re-entry vehicle, and at high enough densities and velocities, radiation becomes the dominant form of heat transfer from the hot, compressed gases ahead of the vehicle. Moreover, under certain conditions, equilibrium is reached in which a body will radiate heat away as fast as it is received.

An important drawback here has been the fact that equilibrium temperatures for today's re-entry vehicles are well above the destruction temperatures of most materials. Ceramic materials similar to those used on the Mark IV re-entry vehicle for the Titan, for example, start to melt around 3,200F. At this temperature, radiation heat transfer is not too significant. But radiation rises by a factor of 2⁴ with temperature. Thus at 6,600F, the sublimation temperature of graphite, radiation heat transfer is roughly 16 times greater and more important. However, says an HTM scientist, a Mark IV type of vehicle made of pyrolytic graphite would reach an equilibrium temperature well before it reached the sublimation temperature of the graphite. In this temperature differential lies the potential for increasing the re-entry velocity by further streamlining of the vehicle, he adds.

Heat Diffused

Local heat input per unit area is generally highest at the tip of the re-entry vehicle nose cone. Highly streamlined nose cones made of most materials would decompose quickly. In the case of pyrolytic graphite, however, the material's thermal anistropy would serve to spread this heat over the surface, therein turning the entire re-entry vehicle into a radiating body. At the same time, a Materials technician points out, this characteristic serves to block the heat going through the PG heat shield.

It is possible, according to pyrolytic



PYROLYTIC GRAPHITE producers are now able to fabricate a variety of shapes such as these produced by High Temperature Materials, Inc. What appear to be flaws in some of the structures are simply outsized grains.

graphite producers, to obtain a temperature drop of approximately 4,000F across a piece of PG only 125 mils thick. In the case of re-entry vehicles, this means that the metal backup structures can be made from the lightweight but relatively low temperature metals such as aluminum and magnesium, technicians say. In the case of rocket nozzles, it means that the heavy metal heat sinks now used with refractory liners can be eliminated.

Tests indicate, it is reported, that pyrolytic graphite nozzles exhibit high resistance to erosion and oxidation regardless of the propellant used or temperature attained. The high surface temperature of PG nozzles also tends to discourage the formation of oxide deposits from propellants with large metal contents. Even more significant, it is claimed, is the fact that the PG nozzle reradiates heat back into the exhaust instead of letting it escape into a heat sink. Also, since pyrolytic graphite does not ablate or erode significantly, the nozzle maintains its original design. This factor is even more critical in reentry applications where changing configurations can lead to aerodynamic instability and loss of accuracy.

Pyrolytic graphite as such is not new, but the ability to produce the material in large quantities is new. Basic method now being used to produce the material consists of running hydrocarbon gases such as methane or natural gas through a vacuum furnace at temperatures ranging from 1,900 to 2,500C. As the gases decompose, the carbon deposits in an orderly fashion, layer by layer, on a mandrel in the furnace. Hydrogen and most impurities are pulled on through.

The mandrel, generally made of regular graphite, may become part of the finished structure. If it is not to be used in the finished part, it is broken away from the pyrolytic graphite piece which is then machined and either used as is or is attached to a different substructure.

Joining or bonding pyrolytic graphite to other materials is one of a number of problems PG producers are now trying to solve. Another is design. When a pyrolytic graphite structure cools down, it tends to shrink more in one direction than another, inducing stresses in the material. Producers such as High Temperature Materials are trying to work out designs and other process variables so that they can fabricate pyrolytic graphite structures in such a way that these stresses won't affect the other properties of the material. In many instances, they are also getting in on the initial design of end products such as rocket nozzles "to ensure that pyrolytic graphite's full potential is utilized."

Perhaps the most critical problem at this time is that of quality control to ensure uniform reproducibility. PG producers are still working on the problem of classifying properties such as grain size and density. Once the material's properties are completely classified, the problem becomes one of developing non-destructive inspection techniques to measure these properties. Another important consideration here, of course, is adequate control of process variables to ensure that a given set of properties can be obtained upon demand.

Handling also is somewhat of a problem with pyrolytic graphite structures, which are relatively brittle at room temperatures when compared with metal structures. High Temperature Materials does not consider this a problem, and says that care in handling is all that is required. By and large, PG producers don't consider any of their problems insurmountable and figure that they could go into production of full scale nose cones and nozzles in a matter of months.

The limiting factor, they say, is the time it will take their customers for ground and flight evaluations.

Defense Policy Council Airs R&D Management

Washington—Defense research chiefs will isolate specific management problems in a broad effort to coordinate the $4 billion research, development, test and evaluation program. This is one result of the first management problems conference sponsored by the Defense Research and Engineering Policy Council held recently at Ft. Monroe, Va. (AW July 11, p. 25).

At the conference, military service research chiefs with their civilian and military program managers aired a variety of general management problems in the growing research and development effort. Discussions ranged from difficulty of military-industry communications to frank advice on what the military services want from Dr. Herbert F. York, director of defense research and engineering, and chairman of the conference.

York was asked to list long-term objectives, establish operating methods, and set a defense research and development policy.

The military services agreed that separate system requirements dictate distinct research by each. Any overcentralization would be harmful. This apparently sets the framework for each service to continue basic and development research under broad guidelines from York.

These were other major positions discussed:

• **System of using Air Force** and Navy design services for Army aircraft complicates difficult communications problems with industry. Different requirements for the same aircraft result in compromises which affect performance.

• **Government research** and development needs guidance from one top source, proper funding unhampered by lack of continuity, a more attractive career program, timely management decisions and a working atmosphere conducive to research.

• **York's office** is exercising scientific influence on military decisions by insisting on more adequate initial analyses of projects by the services and by maintaining closer liaison with the Joint Chiefs of Staff.

• **Government laboratories** should not compete with industry; each plays a different, mutally supporting role. Industry should be assigned all production tasks, except in special circumstances, beyond the initial prototype.

• **Individual service management** eliminates the tendency to over-control and over-justify, but allows faster identification of non-productive research and development efforts.

• **Government laboratory problems** include many levels of program justification, efforts to compress lead time, lack of support for research and development construction, retention of personnel, and changes during the contract cycle. Auditors tend to control, and there is frequent "close direction of research" from outside the laboratory.

• **Three major phases** in the life cycle of a weapon system are development, debugging and service use. The second phase should be used to correct deficiencies as the completed system is introduced, and should not be a prolonged improvement program. Tendency to "inch-up" by extended improvements prohibits the project officer from meeting his requirements; performance gains are not effective substitutes for bold leaps.

• **Transition of the mission** of the Atlantic Missile Range from pure weapons test to include space launch support has added problems of timing, technical complexity and scope.

Daystrom Awarded Contract For Julie Sonobuoy R&D

Washington—Daystrom, Inc., has a $2 million Navy contract for continued research and development work on the Julie echo ranging system.

Julie will be an active sonobuoy using an explosive sound source. It will be dropped and monitored by patrol aircraft as an advanced detection and localization system in the Atlantis large area surveillance study project.

Daystrom Electric Division is using an indoor acoustical water tank, stone quarry and the research vessel State Star in the Julie program.

Boeing Cancels Report at ARS Meeting

Columbus, Ohio—A report on a propellant system claimed to significantly exceed the specific impulse performance of liquid hydrogen and liquid fluorine was canceled by Boeing Airplane Co. at the last moment at the American Rocket Society's Propellants, Combustion and Liquid Rockets Conference here last week.

The report on "The Ultimate Chemical Propellant," prepared by four Boeing researchers, had been reviewed and accepted by the American Rocket Society's liquid rockets committee, composed of specialists in this field from several companies. The report was to be a major presentation at the conference and was also scheduled for an International Astronautical Federation meeting in Stockholm Aug. 15-20. Copies were sent to Europe for review.

The specific impulse performance of liquid hydrogen and liquid fluorine has long been regarded as the ultimate in straight chemical propellant combinations. At virtually the last minute Boeing withdrew the report, declared it proprietary information, asked those who had already read it not to disclose its contents, and finally is believed to have persuaded the military to make it classified.

The report was regarded as highly controversial by most of those who were familiar with its contents, but this was one of the main reasons the conference committee wanted to present it.

In an unusual move, the committee had scheduled it for a complete session of its own so that there could be ample time for discussion.

Multi-Component System

The paper reportedly described a propellant system believed to be a multi-component system consisting of three and possibly four different components, somewhat along the lines, for example, of a mixture of beryllium and lithium fuels oxidized by a combination of liquid fluorine and ozone.

Individual reactions varied among those persons claiming to be familiar with work in this particular area. Some said it was impossible to achieve this performance; others said it was theoretically possible on paper but that such systems could never work in a rocket engine. Many said the authors must have made mistakes in their calculations, and a few people, including one of the authors of the report, said that the Boeing group had actually accomplished what it said it had. There was general disappointment that the company had prevented the report from coming out for open discussion.

There was also a widespread feeling of dissatisfaction among those attending the meeting with the large amount of what they considered marginal material that was allowed to be presented at the conference. Of the approximately 30 reports that were given at this conference, only six or so appeared to generate genuine and fairly extensive interest among the audience at a given session.

A number of people such as Emerson W. Smith, chief of power systems at North American's Columbus Division and a conference luncheon speaker, attributed this situation in part to the vast, unnecessary number of technical society meetings. There are 105 engineering societies, he pointed out, 56 of which hold meetings in the aviation-space technology area at the rate of approximately 140 meetings a year.

Some people said that a specialized conference of this kind just couldn't pull in enough quality papers on an annual basis and would be better scheduled for every two years. Others attributed the blame to the problem of security and declassification coupled with the creation of government-sponsored classified meetings such as one held last fall by the recently established Liquid Propellants Information Agency.

Among the more interesting presentations was a report by Rocketdyne's C. A. Hauenstein on the development of a tap-off rocket engine system in which combustion products, bled from the thrust chamber, are used to provide turbine power. Principal attraction of this system, according to Hauenstein, is that it eliminates the need for a separate gas generator system to power the liquid propellant turbopumps and thus produces a significant increase in the reliability potential of the rocket engine.

To prove the feasibility of the tap-off concept, Rocketdyne adapted the system to an Atlas MA-2 sustainer engine which burned liquid oxygen-RP-1 propellants and provided a thrust of approximately 58,000 lb. The MA-2 represented a readily available and economical testbed, said Hauenstein, and the fact that its components are similar to those in other, larger Rocketdyne systems meant that test results could be scaled up for other applications.

Rocketdyne ran 64 tests with the modified MA-2. Among other things, these tests revealed an area in the combustion chamber where the temperature was sufficiently low for the gas to be bled directly to the turbine without requiring the injection of diluent propellant for cooling, thereby permitting extreme simplicity in the design of the hot gas system.

A comparison of the tap-off system with a representative gas generator system with regard to hardware and required operating functions, Hauenstein reported, indicates that a reduction of approximately 60% in potential problem areas can be achieved through use of the tap-off system, a significant reliability consideration for future engine systems.

At the same time, he pointed out, the performance of the tap-off system is comparable to that of a conventional engine.

In the current type of bi-propellant gas generator system, fuel and oxidizer are bled from the main engine propellant feed system and burned in a separate combustion chamber to produce the hot gas required to power the turbine that drives the propellant pumps. Such systems require precise propellant sequencing, ignition, injection and flow control.

Tap-Off Operation

In the tap-off system, the engine is started with a solid propellant turbine starter.

Combustion products are bled from the thrust chamber, through a hot gas duct, to the turbine and then out through an exhaust duct. By the time the starter burns out, Hauenstein said, the turbine has already made a smooth transition to the bleed gas.

A comparison of the two systems made by Hauenstein revealed the following:

- **Conventional bi-propellant** gas generator system has to perform seven different functions, while the tap-off system performs only two.
- **Gas generator requires** 11 components, the tap-off six.
- **Gas generator has** 11 static seals, the tap-off system has three.
- **Gas generator requires** three dynamic seals while the tap-off doesn't require any.

Impressive as Rocketdyne's work in this area appears to date, essentially it constitutes only an experimental demonstration of the feasibility of a liquid oxygen-RP-1 tap-off engine system. Before this system can be fully exploited in future engines, Hauenstein said, a lot more work will be required to determine if the tap-off techniques which have evolved from this program can be applied to alternate propellant combinations, hardware configurations and operating levels. If this proves to be the case—and he is fairly optimistic about the system's prospects—then, he said, it means that a technique will be readily available for obtaining significant improvements in the reliability of large liquid-propellant rocket engines.

GAO Report Highlights Space Competition

By Evert Clark

Washington—High degree of competition that has marked space hardware development contracting was emphasized again last week by a Government Accounting Office investigation of the choice of Douglas Aircraft Corp. to build the fourth stage airframe for the Saturn space vehicle.

This was the fourth major National Aeronautics and Space Administration development program to come under careful congressional scrutiny since NASA was created less than two years ago. Others are the F-1 engine, the Mercury capsule and the 200,000 lb. thrust hydrogen engine contracts.

Aside from the Mercury manned space capsule, the Saturn stage was the most important airframe competition held so far by the space agency. Eleven firms, faced with a declining number of military aircraft and missile systems, answered NASA's call for bids. They included 10 large aviation companies and the Chrysler Corp., which had built the Jupiter intermediate range missile.

Stage Combinations

The Saturn stage, designated S-IV has an importance beyond the fact that it is the first large rocket airframe development to be awarded by NASA. Saturn is to have five and possibly six different stages, to be used in a number of combinations. The first stage is being developed and assembled by NASA's Marshall Space Flight Center, at Huntsville, Ala., at least through the first 10 or 11 vehicles. Saturn stages are numbered from the booster up, and the fifth stage—or S-V—already is being developed by Convair, since it is borrowed from the Atlas-Centaur vehicle.

The three intermediate stages and a possible nuclear stage, therefore, are the only ones to be developed by private industry under new competitions. As AVIATION WEEK pointed out early this year (AW Jan. 11, p. 26) Saturn is expected to be a key vehicle in the nation's exploration of space, and bidding for all phases of its development will be hard fought and may play a large role in deciding which companies will remain in the space development picture in the future.

Chrysler hoped it had an advantage in the competition, held last spring, because it had worked with the former Army team at Marshall on the Redstone and Jupiter missiles and on Saturn's first stage. Convair, then developing the only liquid hydrogen stage in this country (Centaur, or S-V), thought this gave it an advantage because stages two, three, four and the projected nuclear stage will all be hydrogen-fueled.

All the companies involved hoped that the winner of the S-IV stage would automatically gain an advantage for the time when NASA opens bidding on stages two and three, which will use the large 200,000-lb. thrust hydrogen engine.

An NASA technical evaluation committee, a business evaluation committee and a source selection board reviewed the bidding last April. Contenders were narrowed to three—Convair, Douglas and North American—and then North American was eliminated.

On Apr. 19, the source selection board made a presentation to NASA Administrator T. Keith Glennan. Glennan subsequently expanded that this included "the chronological steps taken in the evaluation process, the technical and business evaluation data in great detail, and the board's analysis of that data. Thereafter I selected the Douglas Aircraft Co., Inc. . ."

Intense interest that had preceded the selection of Douglas and the complaints that followed from losers prompted the House Committee on Science and Astronautics—among other congressional groups—to investigate.

Glennan stated the following four reasons as being "among the considerations" influencing his choice:

• **Technical competence.** This was for Douglas and Convair "nearly the same, as revealed in their proposals." Convair had "a slight edge" that "did not seem to me to be controlling," Glennan said. "The Douglas proposal, in some ways, seemed more imaginative. Conversely, the rather lower rating given to Convair by the business . . . committee would seem to indicate only that attention to certain of the details of organization was lacking. In the course of negotiation of the contract, either of these shortcomings would be corrected in all probability. Convair's work on Centaur undoubtedly gave them a slight edge in the technical competition."

• **Competition.** "Considerable importance must be given to a consideration of the desirability of at least limited competition as we start off this new technology," Glennan said. "Should all work be centered in one company, it might well be the case that subsequent competitions for the other stages of Saturn would become quite one-sided. A monopolistic position in this field seems possible and should be avoided unless substantially increased costs would be involved or unnecessarily complicated management arrangements result.

"An examination of these factors produces a negative result—that is, no important cost or management problems are expected to arise if a second industrial organization enters the field," Glennan continued. "Indeed, some benefits may well accrue. Broadening the industrial base in hydrogen vehicle technology is in the best national interest." NASA appears to follow this philosophy in awarding development of the 200,000-lb. thrust hydrogen engine to Rocketdyne, rather than to Pratt & Whitney, which was developing the 15,000-20,000-lb. thrust hydrogen engine for the fourth and fifth Saturn stages.

With regard to Glennan's statement on costs, Convair bid $59,208,000 and Douglas $64,648,000, exclusive of fee, for the S-IV job—a difference of $5.44 million.

• **Interference.** Both Douglas and Convair are primary Air Force contractors, but USAF assured NASA that the Saturn work would not interfere with "on-going or planned Air Force programs." Glennan said USAF offered assurances "that capacity was available in both organizations—perhaps a bit more completely in Douglas, but adequately available in Convair."

• **Share of Business.** "Convair's continuation with Centaur (S-V) ensures a larger share of production business for that company since S-V will be used both with Saturn and Atlas—in fact, may well become one of the 'work horses' of the space program in both military and non-military activities," Glennan said. "Thus, loss of the S-IV contract has more positive features in the initiation of competition than disturbing features in the possible loss of significant amounts of on-going business. Both operations will continue to be healthy—not unnecessarily starved to achieve competition."

Interest in Chrysler

Although Glennan's comments dealt with the relative positions of Douglas and Convair, the space committee paid most of its attention to Chrysler's position, since Chrysler had proposed building a plant near the Saturn launching site at Cape Canaveral, Fla.

Glennan's comments dealt with the relative positions of Douglas and Convair, but the space committee addressed two of its three "matters of interest" to Chrysler's situation in asking the Government Accounting Office to study the Saturn award.

Chrysler had proposed building a plant on a 14,000 acre site on North Merritt Island, 15 mi. from the Saturn launching pads, if it won the award. This was not, as the committee told GAO it had heard, a plant "for development of the second stage," and was not

Westland Westminster Fuselage Enclosed

Westland Westminster turbine-powered crane/transport helicopter, long flown with its airframe structure exposed (AW May 18, 1959, p. 96), is shown with the fuselage faired over as for a troop-carrying mission. Horizontal stabilizer is new. Rotor is a four-blade version; first flight with a six-blade rotor head was made July 13 (AW July 18, p. 38).

to be built "with [Chrysler's] own funds" as the subcommittee believed. It was to be an assembly and static test facility, jointly financed, and including a final assembly building, a blockhouse, a static test stand and other site improvements, according to GAO.

Although the GAO report does not mention this, Glennan was questioned on Capitol Hill about his choice shortly after the Douglas award, chiefly as a result of unhappiness in the Florida and Michigan congressional delegations. Chrysler had proposed use of the Army-owned, Chrysler-operated Michigan Ordnance Missile Plant at Detroit for design, manufacture and subassembly work. Michigan's unemployment rate and Chrysler's declining missile work influenced the feeling in Congress about Chrysler's loss of the competition. The Michigan plant was being picketed by unemployed missile workers on the same day that Glennan made his explanations on Capitol Hill. Among the facts he offered in clarification of his choice was that Chrysler had not been among the top few bidders in the technical ratings. Still another factor, unmentioned by the GAO report but influencing pro-Chrysler sentiment, was the fact that the nation's largest liquid hydrogen production plant is located at West Palm Beach, Fla., only 200 mi. south of Chrysler's proposed assembly and static test site.

Chrysler, according to the GAO, had estimated that $2,745,024 would be needed for government-financed equipment. Of this, $2,617,924 would have been applicable to the assembly and test facility. To reduce funding required there, Chrysler proposed to transfer government-owned machine tools and other equipment from the Detroit plant, to reduce government funding required from $2,617,924 to $1,735,643.

An alternate Chrysler proposal to build the new facility on the Tennessee River near the Marshall Center in Alabama—where stages must go for checkout and mating to Saturn's first stage before they go to the launch site—was rejected by the business committee, which had found the Florida site was "well selected and optimum for the program," according to GAO.

The other two aspects which GAO was asked to investigate were:

• **"Practicability of selecting** a contractor whose product will have to be shipped an estimated 10,000 mi. by water from its plant in California to the Cape Canaveral launching site." GAO found that transportation plans in all proposals were acceptable to the business evaluation committee from the standpoint of time required to deliver the stage from factory to Alabama.

GAO also found that the source selection board said "that excellence of the technical proposal should be the dominant factor in choosing top place contenders for final consideration;" that only 1.1 points had been allotted to transportation out of 200 possible points in the technical evaluation committee's scoring; that 1.1 points could not have affected relative standings of any bidder because of the point spreads finally assigned; and that all three of the top three contenders had West Coast plants, so that transportation from California was not a factor in selection of Douglas.

Transportation costs to Huntsville do not appear to be a significant part of total development cost, GAO said. Contractor estimates for transportation cost and total development cost, excluding fee, were: Convair, $704,000 out of $59,208,000; Douglas, $426,000 out $64,648,000; North American, $275,000 out of $42,199,000, and Chrysler, $343,000 out of $41,839,000.

• **An indication in Glennan's** statement that broadening the industrial base in hydrogen technology "played an important, perhaps overriding, part" and that "another contractor might have been selected if it had not been for this consideration."

GAO replied that "it seems reasonable to conclude [from Glennan's statement] that the consideration of broadening the industrial base in hydrogen vehicle technology was the deciding factor . . . whether this consideration was a compelling factor in its own right, or whether it was merely sufficient to tip the balance between Douglas and Convair, cannot be determined."

The House committee, under Chairman Overton Brooks (D.-La.), has paid similar close attention to NASA's award of the 1-million lb. thrust F-1 engine contract to Rocketdyne, the McDonnell Mercury contract and the selection of Rocketdyne to develop the 200,000 lb. thrust hydrogen engine. No report has been issued on the latter. The committee also instigated GAO's recent investigation of the cancellation of NASA's Vega space vehicle program.

The Senate Aeronautical and Space Sciences Committee also has kept a critical eye on NASA's procurement. Some NASA employes feel that this critical surveillance is not all warranted and that some attention might better be turned to procurement practices of older, more experienced agencies.

Russians Assembling Large Hydrofoil Boat

Moscow—Krasnoe Sormovo factory has started assembling the Soviet Union's largest hydrofoil boat, the 300-passenger Sputnik which will have a top speed approaching 62 mph., according to Komsomolskaya Pravda.

Regular passenger service with hydrofoil craft is reported expanding at a rapid rate on Soviet waterways. A Rocket-4 has begun scheduled service across Lake Baikal. A 150-passenger Meteor hydrofoil made its first Moscow-Gorki run early in July and later will be assigned to Gorki-Kuibyshev operations on the Volga River (AW Mar. 14, p. 113).

More than 20 hydrofoil "Rockets," each capable of carrying 66 passengers, are expected to be in regular service on the Volga and such large Siberian rivers as the Lena, Angara, Yenisei and Irtysh by the end of the year.

First Polaris Launched From Submarine

By Edward H. Kolcum

Cape Canaveral—Tempo of Navy-Lockheed Polaris program increased last week as three missiles were launched in a 27-hr. period, two of them in the first test flights from a submerged nuclear submarine.

Initial submarine launches were made at sea from the USS George Washington in a Polaris operating area 30 mi. off Cape Canaveral. Launches from the George Washington will be scheduled frequently as the accelerated development program moves into its final phases and the missile submarine system prepares for fleet duty.

Both submarine-launched missiles flew 1,000 naut. mi. down the Atlantic Missile Range. At the same time, a Polaris test vehicle was launched 1,060 naut. mi. down range from a flat pad here. Navy planned to fire two or three more test vehicles late in the week.

In the first submerged launching, Polaris vehicles were fired from two tubes by compressed air, and first stage ignition occurred when they were about six feet above the surface. Built-in roll error in the first launch was corrected by jetavators.

Aerojet-General solid propellant first stage motor, developing 65,000-lb. thrust, burned about one minute. Then the stages separated and the Aerojet second stage motor burned about 70 sec. and boosted the vehicle to an apogee of 400 mi. and a range of 1,000 naut. mi.

Because of its mobility, Polaris has been offered as a medium range missile to North Atlantic Treaty Organization countries. It can be fired from a relatively simple launch pad, has a short countdown and can be launched from land, railroad cars or barges. Soviet Union has protested against any plan to arm West German forces with Polaris missiles.

Accelerated Program

Tests last week are evidence of Navy's emphasis in the expanding, accelerated Polaris program, which has had approximately 70 launchings in 31 months. Navy is staking its Polaris reputation on having both the George Washington and Patrick Henry missile-ready before the end of this year. Polaris program was announced in January, 1957, and first test vehicle was fired a year later.

An exceptionally large number of vehicles will be launched in the test program because instrumentation is limited in size and weight for each flight. Missile envelope already is standardized, and specific problem areas are eliminated by establishing fixes and assuring that failures do not mask other problems. While this method involves a greater number of launches than normal, component deficiencies are rectified on a step-by-step basis, Navy said.

Concurrency of ground and flight test programs has demonstrated a phenomenal engineering design judgment, according to Stanley Burris, Lockheed Polaris systems manager. Because few major changes have been made in the basic design, Navy has been able to use production missiles as test vehicles, and Lockheed has been able to go into full-scale production without major assembly line modifications.

Burris said that, in general, problems have been small. Both he and the Navy identified exhaust heat as the major problem to date. Exhaust had two main effects in missile performance: Aluminum deposits from propellant mixture formed on jetavators, preventing them from following mechanical commands from the guidance capsule; and exhaust waves in the four-nozzle array have a tendency to turn inward. In Polaris, this resulted in a burned-out hydraulic system.

Problems Solved

Dual problem was solved by using new materials for nozzles and jetavator collar, and stronger insulation between exhaust and hydraulic system.

Completely integrated weapon system test is one step prior to fleet evaluation, Navy said. Program to date has involved these diverse facilities to check out the missile, ejection, submerged launcher and integrated system:

- **Flat pad** and Ships Motion Simulator (SMS) at Cape Canaveral flight tests of the missile.
- **Operations Popup and Fishhook**, testing the ability of the missile to be launched under water and be ignited by an accelerometer type system. Accelerometer senses when missile reaches peak of compressed air launch path. These tests are held off San Clemente Island, Calif.
- **Operations Skycatch** and Peashooter, dry-land operations at Hunters Point in San Francisco naval shipyard which pioneered methods of ejecting the missile.

Integrated systems launches are possible from the USS Observation Island. Full duplication of submarine launch exercises Polaris navigation, fire control and guidance elements.

Navy also has studied Polaris in wind tunnels, shock tubes, environment laboratories, on rocket sleds, centrifuges, and static and dynamic test stands.

For first submarine-launched systems test, Navy added 12,000 lb. of evaluation instrumentation on George Washington. Test gear is in 88 packages, modular in design, linked by plug-in connectors and clipped together for rigidity.

Instruments are used to record launch behavior, checkout and digital recording. Navy has two sets of the 88-pack equipment, one on board the test boat and the other being checked out in Building No. 8 at Port Canaveral.

Motion picture cameras in watertight cylinders on top of the hull obtain data film for each launch.

Cost of Program

Complete 45-boat Polaris program will cost $8.645 billion, including full funding for submarines, 1,005 missiles, development, launch equipment, fire control, ships' navigation equipment and personnel training.

Congressional confidence in the program has raised to 21 the number of Polaris submarines either in commission, under construction or authorized. The George Washington and Patrick Henry are in commission. The Theodore Roosevelt, Robert E. Lee and Abraham Lincoln have been launched and are outfitting. Four others are under construction, two by the Newport News Shipbuilding and Drydock Co. and two by the Electric Boat Division of General Dynamics Corp.

Five boats were funded in the current defense appropriation, which also contains money to buy long lead time items such as reactors and powerplants for seven additional subs.

Navy has a long-range plan to complete program funding over the next four fiscal years. Each boat has an average construction-outfitting cost of $100 million. Time from contract award to fleet service has been compressed from the normal three to four years to a two-year maximum. Unit cost of each tactical missile will be under $1 million.

Because of relatively small tolerances in shipboard missile accommodation—missile is limited to a 4.5-ft. dia. but can grow to a maximum of about 31 ft.—increased range will depend on further miniaturization, decreasing weights of inert components, and by increasing specific impulse of propellants. Aerojet is favoring an aluminum additive to raise energy content in the second stage, and is increasing the amount of first-stage fuel.

Hercules-Allegany Ballistic Laboratory has an engine backup contract and is developing a double-base propellant with higher specific impulse. Double-base solids require more stringent handling limitations than present formula.

Already earmarked for weight reduc-

tion is the 250-lb. General Electric Ordnance Department inertial guidance capsule, located in the instrument section aft of the warhead. Liquid-floated single-axis gyros in this package are erected and aligned by Mk. 80 fire control system to put the vehicle on course at time of launch. During flight, servo mechanism links the guidance capsule to the jetavators for steering commands.

Cross Check

Real time ship's position is given by three Ship's Intertial Navigation Systems (SINS) and digital computer, all of which keep a cross check on the others. Data from SINS, star-tracker, speed log and ocean currents are fed into fire control system.

Lockheed's Sunnyvale plant mates the re-entry body, instrument section, interstage connector, the flight controls and circuitry to inert motors and conducts the systems checkouts. The missile then is broken down into sections and if it is a test vehicle, it is flown from Moffett Field, Calif., to Cape Canaveral.

Tactical Missiles

Tactical missiles are air-shipped from Moffet to Naval Weapons Annex in Charleston, S. C., for final assembly and checkout, storage and fleet issue.

Major subcontractors to Lockheed, in addition to Aerojet and GE, are Hughes Aircraft Co., guidance; Northrop's Nortronics Division, checkout and readiness equipment; Westinghouse and GE, fire control; Sperry Gyroscope Co., ships navigation, and North American Aviation's Autonetics Division and Massachusetts Institute of Technology, advanced guidance, fire control and navigation equipment.

Zeus Test Facilities

Washington—Facilities for maximum-range test launchings of Army's Nike Zeus are essentially completed at Pt. Mugu, Calif., and are due to be turned over to Navy, which operates the Pacific Missile Range. Firings will begin next year from a slant-rail, above ground launcher, and missiles will be guided. Army-operated inland range at White Sands, N. M., is not large enough for full-range firings.

Army Corps of Engineers has supervised construction at Pt. Mugu. After Navy completes acceptance inspections, facilities will be turned over to Army Rocket and Guided Missile Agency, developer of Zeus, for installation of equipment. The full-range firings will precede firings of Zeus from Kwajalein Atoll in the Central Pacific at Atlas intercontinental missile warheads launched from Vandenberg AFB (AW July 4, p. 39).

U.S., Soviet Union Trade Threats Over RB-47 and Cuban Situations

Washington—U.S. and the Soviet Union continued to swap accusations and warnings last week over the shooting down of a Strategic Air Command RB-47 and Soviet Premier Khurshchev's promises to back Cuba with Russian rocket power against any U.S. "aggression."

Debate on the RB-47 case (AW July 18, p. 28) was scheduled to begin before the United Nations Security Council, where Russia lost an attempt late in May to have the U.S. censured for flight of the U-2 reconnaissance plane over Russia on May 1.

The Security Council last week voted 9 to 0 to have the Organization of American States consider Cuban charges that the U.S. has committed "economic aggression," and to study whether Khrushchev's threats to enforce guardianship of Cuba by using 8,000 mi. range Russian missiles constitutes an attempt to establish a foreign political system in the Western Hemisphere in defiance of the OAS.

The vote followed a bitter U.S.-USSR exchange before the council, in which Soviet Delegate Arkady A. Sobolev warned: "Do not touch Cuba. Leave it alone.

"Let it do what it deems proper in its own country, and do not threaten Cuba with your might because other countries also have such might."

Russia announced that U-2 pilot Francis G. Powers, whose plane was downed near Sverdlovsk, will be tried Aug. 17 in an open court session of the military college of the USSR Supreme Court.

Russia agreed to return the body of the RB-47's pilot, Capt. William A. Palm. It said the RB-47 violated its borders 13.67 mi. north of Svyatoy Nos Cape and was shot down after it turned toward the city of Archangel and appeared east of the cape. The two survivors Russia claims to have were picked up by ship, Russia said. The survivors said they were forbidden to break radio silence to communicate with a rescue station on the northwest coast of Norway, Russia said.

Britain and Norway, accused by Russia as "accomplices" in the RB-47's flight, generally backed the U.S. in rejecting the Soviet charges. British Prime Minister Harold Macmillan and President Eisenhower exchanged correspondence on modification of the U.S.-U.K. basing agreements. State Department and the British Embassy representatives here have begun negotiations.

Meanwhile, Russia continued to attack U.S. use of bases in Denmark, Norway, Turkey and Spain and filed a formal protest charging that U.S. military aircraft have buzzed Soviet civilian shipping 250 times in the first five months of this year. Russia said she will "have to take other measures" to protect its shipping if such actions continue. The violations include, dives, simulated torpedo and bombing runs, and dropping of "various moving objects and incendiary devices in the direct proximity of the ships."

Cockpit View of B-58 Hustler

Interior view of Convair B-58 Hustler shows right hand stick control for operation of hydraulically powered control system. Throttles for Hustler's four General Electric J79 turbojet engines are operated with left hand.

French Five-Year Military Plan Calls for Nuclear Strike Force

Paris—The French government, after months of debate and delay, finally has published its five-year military program which provides for the development of an independent nuclear strike force.

General outline of the program contains nothing startlingly new. Military thinking behind the plan, notably the development of an independent strike force, has been the major theme of the French government for several years. However, the plan does reveal for the first time specific amounts which the French plan to spend in various military categories.

The five-year plan, which stretches from January, 1960, to January, 1965, is based on fulfilling three basis military missions.

These are:

- **Defend French national interests.**
- **Meet special defense missions** in Africa and elsewhere in the French community.
- **Meet French commitments within** NATO.

To meet this three-mission task the French plan to spend some $6.232 billion on various projects over the coming five years. The published five-year plan, however, is concerned only with major projects which, because of their long lead time, have to be planned over several budgetary periods. Thus the published plan deals with major programs which will cost $2.558 billion over the coming five years.

These major five-year defense projects are grouped in the following categories:

- **Aircraft.** Fifty Dassault Mirage IV strike bombers at a total cost of $200 million. Two hundred and seventy air force tactical fighters and interceptors at a total cost of $354 million. Seventy air force training aircraft at a total cost of $12 million. Eighty air force light transport aircraft at a total cost of $35 million. Fifty navy carrier aircraft (fighters) at a total cost of $50 million. Twenty-seven Breguet ASW Atlantic aircraft at a total cost of $92 million. Two hundred and twenty helicopters for all three services at a total cost of $62 million.

In addition to these aircraft orders, some of which already have been placed this year, the government will spend in this aircraft category $75 million on nuclear strike force studies and on NATO ASW studies. Thus over the next five years France will be spending a total of $881 million on major aircraft projects.

- **Nuclear weapons and missiles.** Total of $800 million will be spent on research and development of nuclear weapons including construction of an isotope separation plant. Total of $58 million will be spent on French participation in the NATO Hawk anti-aircraft missile program. Total of $154 million will be spent over the next five years in developing a French intermediate range ballistic missile.
- **Naval vessels.** Total of $102 million will be used in financing construction of three missile-launching cruisers while $63 million will be spent on construction of three submarines, one being nuclear-powered.
- **Army ground vehicles.** Total of $300 million will be spent over the coming five years for purchase of combat vehicles and trucks.

About 50% of this five-year plan is taken up with development of France's nuclear strike force. This force—based on Mirage IV bombers—should be operational by the time the plan runs out in 1965. Some critics, however, already are complaining that by 1965 any strike force based on aircraft will be useless, that the $200 million earmarked for the Mirage IV will be wasted money. The program probably will be further aired when the five-year plan comes up for debate before the assembly early next fall.

New Group Will Review Company Program Cost

Washington—Defense Department has formed a new Armed Services Research Specialists Committee to review industry-proposed independent research and development programs and recommend the extent to which they should be supported by Defense Department as allowable items of expense under cost reimbursement type contracts.

The action is a direct outgrowth of recent revision to Section 15 of the Armed Forces Procurement Regulations which differentiates between research and development for cost reimbursement and tightens the eligibility requirements for development (AW Feb. 22, p. 29).

Company-sponsored research and development programs must pass Defense Department's criteria of "reasonableness" in terms of scope and magnitude, relative to previous company effort. A more controversial criteria, which will be applied only to company-sponsored development programs, is that they must be related to product lines for which the company has government contracts.

Where a contractor does business with several military departments, one will be named to act as joint agent (sponsor) for all departments in negotiations on cost allowability of independent research and development programs.

Upon request of the sponsor department, the new seven-man Armed Services Research Specialists Committee (ASRSC) will review a contractor's proposed independent research and development program to determine whether individual projects are suitably classified as research or development, and will recommend the extent to which it believes each should be supported as an allowable item of expense.

Committee also will indicate whether proposed independent development effort is adequately related to contractor's existing government product line and whether it should be supported by the Defense Department. Where a contractor does not engage in production, the committee will determine whether a proposed R&D program falls within its field of effort under existing government research and development contracts.

Contractors doing business with more than one department, and seeking out cost reimbursement for independent R&D, may be required to submit brochures describing each proposed project and its estimated cost. Brochure would be submitted to the sponsor department before the start of contractor's fiscal year or within the first 90 days of the period.

The Armed Services Research Specialists Committee is headed by H. B. Christenat, Office of Chief of Naval Materiel. Other members include: Willis Foster, Office of Director of Defense Research and Engineering; Dr. R. A. Weiss, Office of Chief of Army Research and Development; R. F. Seager, Army Deputy Chief of Staff for Logistics; Dr. F. J. Weyl, Office of Chief of Naval Research; P. E. Koenig, Office of Commander of Air Research and Development Command; D. R. Babione, Air Materiel Command.

Sikorsky Workers Ask NLRB Election

Possibility of any negotiations between United Aircraft Co. and the United Auto Workers in a seven-week strike at United's Connecticut plants temporarily ended at Sikorsky Division when 1,800 workers petitioned the National Labor Relations Board for an election to determine the bargaining agent.

Indications are that the group intends to form an independent union if it is determined by secret ballot, conducted by the NLRB, that the UAW no longer represents a majority of the workers. Any possibility for continuance

of negotiations bogged down with the move, pending determination of bargaining agent certification, observers said.

Meanwhile, talks between International Assn. of Machinists and United negotiators, involving workers at Pratt & Whitney's East Hartford and Manchester plants and at Hamilton Standard at Windsor Locks, resumed after a two-week breakdown.

United said it now has 22,539 production workers on the job, out of a total of 30,000. On a man-hour basis, the company said production now is 90% of normal.

Meanwhile, the month-long strike against Lockheed's Missile and Space Division by the IAM ended when workers accepted a two-year contract calling for a four cent per hour pay raise this year and another three cents next year. Other benefits include a severance payment of $50 for each year of seniority, up to a maximum of $500.

Lockheed's California Division, with plants at Burbank and Palmdale, had not yet reached a settlement, but officials were expecting one late last week. There are no strikes in progress at California Division locations.

At Boeing Airplane Co., IAM members were scheduled to vote last weekend on a new proposal involving Seattle and Wichita, Kan., facilities. Package is estimated at a 17 cents per hour raise (AW July 18, p. 27).

A strike at Aerojet-General, called for last Monday, was postponed when company and the IAM reached a tentative agreement, which was not disclosed pending membership votes at Sacramento and Azusa, Calif. Wages are the primary issue.

Tentative agreement also has been reached between the IAM and Rohr Aircraft at its Riverside and Chula Vista, Calif., plants. Agreement calls for a four cent hourly pay raise this year, three cents next year.

At Ft. Worth, Tex. representatives of Convair-Ft. Worth and the IAM continued negotiations, with the major issue appearing to be company proposals on job classifications. Convair has offered a four cent hourly wage increase, retroactive to June 6.

Navy Cancels Corvus Development Project

Washington—Navy halted Temco's Corvus missile development program last week, and the company began terminating subcontracts and laying off employes connected with the canceled project.

Navy said it canceled Corvus because review of Navy programs indicated it would be better to shift development funds to "weapon systems offering a wider scope of employment." Navy did not say what system will fill the role planned for Corvus.

Corvus was an air-launched, rocket-powered missile designed to home on enemy radar installations. It had a range of more than 100 mi. and had been test fired at the Naval Missile Center, Pt. Mugu, Calif., from attack aircraft. It was under development by Temco Electronics & Missiles Co., a subsidiary of the new Ling-Temco Electronics, Inc., formed in a merger between Temco Aircraft Corp. and Ling-Altec Electronics.

Temco laid off 200 employes working directly on the program, and further dismissals are expected. Subcontractors involved in the cancellation are Thiokol's Reaction Motors Division, prepackaged liquid rocket engine; W. L. Maxon and Texas Instruments, guidance components; Williamson Co., shipping containers; Horkey-Moore Associates, launcher; Emerson Research Laboratory, target detection; Bulova Research and Development Laboratories, warhead safety and arming components and Talco Engineering Co., recovery system.

Navy estimates the Corvus program cost $80 million before it was canceled. No new funds were allocated for Corvus in the Fiscal 1961 budget, and the Navy apparently decided not to try to squeeze enough money from other programs to continue developing Corvus. Estimated cost of completing development and procurement of the missile was $450 million.

The $80-million cost estimate of the canceled program may vary after the Navy settles cancellation costs and determines whether any funds committed might be recoverable. Executive Vice President Clyde Skeen said the company will submit a program to the Navy which will make maximum use of the hardware and inventory on hand.

Bell HU-1A Shows Missile Firepower

Tactical versatility of missile-carrying Bell HU-1A T-53-powered Army helicopter is demonstrated in this photo showing the Iroquois firing Nord SS-11 wire-guided missiles while sitting on the ground. Note how missiles are mounted in racks so that they are slightly elevated, providing clearance over terrain directly in front of the helicopter. HU-1A can carry six SS-11s (AW Mar. 7, p. 91).

News Digest

Civil Aeronautics Board said last week that concern that Pan American World Airways was attempting to gain its first domestic route through control of National Airlines was the reason for the Board's rejection last April of a Pan American-National stock exchange and option agreement.

Edward H. Heinemann has resigned as vice president-European Division of Douglas Aircraft Co., Inc., to accept an undisclosed position in industry, but remains a technical consultant.

Air Force transferred ballistic missile site activation from Air Research and Development Command to Air Materiel Command to separate this function from development work, and named Maj. Gen. Thomas P. Gerrity as chief of AMC's Ballistic Missile Center. Brig. Gen. Don Coupland remains as Gerrity's deputy.

General Electric Co. last week named David F. Shaw, vice president-engineering of the H. J. Kaiser Co., general manager of its Aircraft Nuclear Propulsion Department and shifted the department to its Flight Propulsion Division. Shaw was director of security for the Manhattan Engineering District in 1946, then moved to the Atomic Energy Commission's Hanford Plutonium works. From 1955 to 1957 he was assistant general manager-manufacturing at AEC headquarters.

North American Aviation's net income for the nine-month period ending June 30 was $16,526,000 after a $17,070,000 federal tax payment, compared with a net income of $21,941,000 for a similar period a year ago. Sales were $717,445,130, against $743,794,864 last year.

Local Airlines to Get Advance Mail Rates

Boyd outlines new subsidy plan to begin Jan. 1; ALTA preparing formula for Board study.

By Ford Eastman

Los Angeles—Local service airlines will operate after Jan. 1 under a new class mail rate plan which fixes payments in advance, Civil Aeronautics Board Member Alan S. Boyd told the Association of Local Transport Airlines at its quarterly meeting here last week.

Although details of the plan have not yet been worked out, generally it would determine in advance, on an industry-wide basis, airline operating costs and expenses, expected revenues and the amount of subsidy required to provide an airline with a profit on its investment. Profits over a certain percentage would be shared by carriers and the government on a sliding scale. Airlines requiring subsidy currently operate on an open rate, with the final rate determined after formal hearings.

In an unusually frank speech at the ALTA meeting, Boyd warned the local airlines that:

- **Subsidy is a financial crutch** and evidence of internal weakness and that "the sooner the industry is rid of it, the better." While drastic cuts are not imminent or desirable now, he said, he knows the carriers and CAB are expected to come forward with plans which will lead to the end of subsidy.
- **The time is fast approaching** for the first large scale review of the "use it or lose it" policy in providing service to communities on a trial basis.
- **Local service airlines** need a broad public relations program directed at the general public to advise and gain public understanding of problems and to obtain public support by showing benefits from local service operations. A similar program must be carried to Congress and the CAB, he said.

Present System

Boyd, in announcing the start of the class mail rate, said the present system is "much too loose today." Neither Congress, the executive branch, the public nor the CAB will be long content with the idea of paying public funds in unknown quantities for an indeterminate number of services, he said.

"The Board at present," he said, "is unable with certainty to fix payments that are required by individual carriers until after a lengthy, tedious, ex post facto review of carrier operations and claims. Disallowances and compromises have us all unhappy."

The class rate system as presently conceived, he observed, should provide carrier management with a sounder basis for operational planning and should provide the Board with a better understanding of what service will be provided for how much subsidy money during the ensuing year. In addition, he said, it is hoped that use of class rates will markedly diminish debate on disallowances of claimed expenses and costs.

William C. Burt, Washington attorney for Bonanza Air Lines, presented a detailed class rate plan to the airlines prepared by a special ALTA technical committee as a start in devising a final plan for CAB consideration.

In developing the details of the plan, Burt said the following principles have been employed:

- **"To place the maximum discretion** and responsibility on air carrier managements.
- **"To use simplified components** of general applicability rather than concentrating on details.
- **"To devise a formula** which generally will produce about the same total dollar level of subsidy as the current methods.
- **"To devise a formula** which will result in a reasonably equitable distribution of subsidy and reasonable carrier operating results for the various local service carriers assuming efficient and economical management."

The four basic elements in the formula, he added, are a standard cost element, an element for profit and taxes, a system-wide load standard and profit sharing and loss carry-forward provisions.

The cost standard selected by the committee is 4.03 cents per scheduled standard available seat mile for total operating expenses expressed in 1947-49 dollars on the basis of the national all-items cost of living index published by the Labor Department. In 1959, this would result in a cost per available seat mile of 4.03 cents plus 1.246 cents, or 5.28 cents per available seat mile, he said.

For both cost and revenue purposes, Burt said available seats were computed on a standard of 24 seats for DC-3 equipment and 40 seats for larger equipment. In the final computation, he added, it may be necessary to establish a separate standard seating and load standard for equipment such as the turboprop Convair 540.

The proposed cost standard was selected over other possible plans for several reasons, Burt said. It is simple, it results in closer correlation among carriers, it adjusts to inflationary changes in cost levels and it would identify for appropriations committees a portion of the subsidy attributable to inflation.

The profit and tax standard selected by the committee is .5237 cents per scheduled standard available seat mile. The profit element is based on the board decision in the rate of return case—12.75% return on investment or 3 cents per mile (AW June 27, p. 41).

"It is our opinion," he said, "that to develop a class rate applicable to a future period, the investment must at least be based on the most current balance sheet data."

Class Rate Basis

Theoretically, he said, a 1961 class rate should be based on balance sheets at the beginning and end of 1961, therefore the rate would have to be based on the balance sheet data available at the beginning.

Burt said a majority of the committee felt that the standard revenue factor should be based on a $1 per passenger charge plus 7.37 cents per revenue passenger mile because of its leveling effect. This computation is a partial recognition of the taper included in the present fare structure, he said.

With the $1 per passenger factor, an increase in traffic would result in a large reduction in subsidy, Burt pointed out. On the other hand, during a traffic lull, such as in winter operations, the carriers' mail pay would be more stable. In addition, as carriers continue to increase flights above the three round trip level, this factor would have the effect of sharply reducing the subsidy.

For express, freight, service mail pay and other transport revenues, the committee selected 5.28 cents per scheduled

plane mile. This figure is based on the industry average for 1959 and, under the proposed formula, is applied only to the first three round trips.

The committee eliminated all consideration of non-scheduled services and incidental revenue from its proposed class rate.

In order to reflect the impact of non-scheduled operations and subsidy requirements, it recommended that profits from such activities be taken into account in computing the amount of profit subject to recapture.

System-wide load standards were selected over previously proposed segment load standards as the best to maintain an over-all subsidy level and lead to the most equitable "fit" among the individual carriers, the committee said. They are designed to eliminate subsidy payments after three round trips, and the revenue reduction factor ranges from 1.23 cents per available seat mile for one system one-way frequency to 5.05 cents for more than six one-way frequencies, depending upon equipment and other factors.

The committee recommended that profit-sharing between the government and airlines be based on a sliding scale. For profit after taxes as percentage of airline investment of 12.75% or less, the airline would retain 100%. From that point up to 15%, the carrier would retain 75%, and from 15.01% to 20%, the carrier would retain 50%. From 20.01% to 25%, it would keep 25% and above that figure the airline would keep only 10%.

Any losses, it maintained, should be applied against any excess profits for a period of five years subsequent to the loss.

Southern ALPA Dispute

Washington—Air Line Pilots Assn. and Southern Airways management remained deadlocked last week in the sixth week of a strike which began over wages, but which now centers about the airline's hiring of non-union pilots during the strike. Attempts by the National Mediation Board to settle the issue also failed last week and left Southern facing ALPA threats to cut off airline service to all cities served by the airline unless the new pilots are discharged and the issues are settled. Despite a walkout of 146 ALPA pilots, the airline reported it has restored service to more than half the cities it normally serves by hiring and training 61 new pilots. Southern said its new pilots have an average experience of 8,000 hr. flight time and are experienced fliers formerly employed by foreign airlines. The airline said its average load factor is 30% higher than in the month prior to the strike, and it is now serving 27 of its 41 cities.

USAF C-130s, C-124s Support U.N. Forces in Congo Republic

By Cecil Brownlow

Wiesbaden, Germany—U. S. Air Force Lockheed C-130 turboprop and Douglas C-124 Globemaster cargo planes on July 20 moved into their second full week in support of United Nations efforts to restore peace in the newly independent riot-torn Congo Republic.

By late last week, 40 C-130s and 36 C-124s, which began to be reinforced by two additional squadrons of 12 aircraft each from the U. S., had flown more than 4,000 troops of five nations into the Congo capital of Leopoldville plus thousands of tons of food, equipment and other supplies ranging in size up to light liaison aircraft, helicopters and mess halls.

Top contingents included 1,073 from Tunisia; 1,200 from Morocco; 600 from Guinea; 650 from Sweden and 550 from Ghana.

As 10 battalions of Belgian troops, which landed in Leopoldville earlier this month under Congo government protests to protect European citizens, prepared to begin withdrawal into pre-established encampments, U. S. Air Force planes were being prepared to fly in at least 1,000 additional Tunisian troops and their equipment and 1,250 Moroccan troops.

Refugee Airlift

Many of the aircraft also were being swung into the giant airlift from the Congo. By late last week, planes had ferried out more than 1,500 evacuees, landing all but one group in Brussels. Exception was a plane loaded with American evacuees which was ordered to the U. S. controlled Rhine-Main Air Base near Frankfurt, Germany.

Over-all control of the airlift is being directed from Wiesbaden headquarters of U. S. Air Force in Europe, with C-130s of the 322nd Air Division flying from Evereux Air Base in northern France, and C-124s of the Military Air Transport Service from Chateauroux Air Base in central France. C-124s are flying under operational control of the 322nd Air Division.

Except for 600 Ethiopean troops flown into Leopoldville by Ethiopian Airlines, USAF has borne the brunt of the U. N. military airlift thus far. Here is a chronology of the USAF effort since it began to move into full swing:

• **July 15**—C-130s, on U. N. request, begin airlifting 300 tons of flour from U. S. Army stocks from Evereux to Leopoldville. Planes, which had been stripped for operation to the point of draining the wing tanks, were sent off with gross loads of approximately 15 tons each, flying the 3,000 mi. route to Leopoldville with refueling stops at Wheelus AFB., Libya, and Kano, Nigeria. Standard peacetime operational procedure was maintained on all flights, including regular crew rests and maintenance checks; no emergency procedures were instituted.

On the same day, other C-130s began moving Tunisian troops from Tunis to Leopoldville. Six C-124s are detached from a MATS rotational squadron at Rhine-Main and dispatched to the Congo with four L-20 liaison aircraft, two de Havilland Otters and Army communications equipment plus the necessary Army flight and maintenance crews for the six light planes.

• **July 16**—C-130s, later replaced by C-124s, began moving Moroccan troops from Morocco to the Congo. Flour airlift is completed.

• **July 17**—Movement of Tunisian and Moroccoan troops, supplies and food continues. (With time out for crew rest and routine maintenance, round trip flight from France requires almost four days.) Two squadrons of MATS C-124s—one located at Donaldson AFB, S. C., and the other at Dover AFB, Del., are ordered to reinforce the 12 C-124s from rotational squadrons.

• **July 18**—C-124s begin moving Ghanian troops from Accra to Leopoldville. Two C-124 squadrons begin arriving at Chateauroux. U. S. Air Force in Europe begins calling in 10 C-47 support aircraft for use by the U. N. command without U. S. crews for local operations in the Congo.

• **July 19**—Troop, supply, and evacuation flights continue. C-47s begin flights to the Congo.

• **July 20**—C-130s begin transport of Swedish troops, who had been assigned to the U. N. security force in the Gaza

Air Union Delayed

Paris—Troubles in the Congo are delaying negotiations over Air Union, a group which will bring together Air France, Alitalia, Sabena and Lufthansa in what could become a single west European air carrier. Top talks between the carriers were postponed recently as Sabena officials were occupied handling emergency flights into the Congo. It is now hoped the carriers will meet late in August. Air Union inauguration date of Nov. 1 is not now likely to be met. Jan. 1 is now being unofficially accepted as the new target date.

strip between Egypt and Israel, from Cairo to Leopoldville. C-124s begin ferrying troops from Guinea to the Congo. Two additional MATS squadrons are assigned from U. S. to help in the airlift.

A USAF spokesman said late last week he expected the U. S. airlift for the U. N. to continue for a "long time," ferrying in additional troops, supplies and equipment, before military control of the Congo can be completely entrusted to local authorities.

The larger bodies of troops being ferrried to the Congo by USAF are flown in by increments since they are accompanied by 500 tons or more of equipment. Tunisians, for example, have been flown in by sections, 593 in the first, 480 in the second. Another 1,000 are still to follow. Moroccans have followed a similar schedule—550 in the first increment, 650 in the second, with 1,250 to follow.

Initial steps leading to the airlift actually were begun July 9 when the Defense Department alerted two U. S. Army companies in Europe and C-130s needed to move them to be ready to move in event the U. N. heeded a Congo request for aid in restoring order. During the period before July 15 when the airlift began in earnest, USAF C-130s transported two small helicopters to Leopoldville to aid in the evacuation of European residents from outlying areas.

Helicopters thus far have been flown and maintained by U. S. Army personnel but, as the U. N. force gains strength, they will be turned over to other nationals, probably Swedish or Norwegian crews. U. S. wants as few of its own troops in the area as possible.

Airlines, USAF Aid Evacuation Of European Refugees From Congo

Massive airlift of European evacuees out of the new Republic of the Congo and of troops and supplies into the riot-torn area continued last week as additional airlines and USAF lent their aid to move thousands of soldiers and tons of food and materiel into Leopoldville.

Sabena Belgian World Airlines' entire jet fleet of five Boeing 707-320s continued shuttling between the Congo and Brussels, carrying as many as 289 passengers on a single flight. Sabena suspended transatlantic service July 9 to put its jets into the emergency operation, and also was using eight DC-7s, 12 DC-6s and a DC-4 in the airlift.

Charter Assistance

By midweek, about 17,000 persons had been ferried out of the Congo by Sabena, with some assistance from chartered planes of other carriers. The Belgian airline was getting an average daily utilization of 14½ hr. with its 707-320s, which were taking off from Leopoldville's 15,420 ft. runway at near maximum gross weight of 310,000 lb. On the 3,869-mi. nonstop flights to Brussels, passengers are crowded four and five abreast with children crammed along the aisles and into closet space. Because of the large percentage of children and infants making up the plane loads, and the paucity of baggage—most adults carry only a handbag—the jets are able to leave Leopoldville with average loads ranging from 250 to 280 passengers. One flight carried 289 passengers and 10 crewmen, the extra crew being stewards to care for the women and children.

Other airlines are pitching in through charter arrangements with Sabena or by U. N. or individual government request. Examples:

• **Air France** has begun an emergency operation of 14 flights between Brazzaville, a city just across the Congo River from Leopoldville in French Equatorial Africa, and Brussels. Lockheed Super G Constellation equipment is being used and the program calls for evacuation of 1,200 Belgian refugees who fled to Brazzaville from the Congo republic. Air France acted on the request of the French Community, to which Brazzaville belongs.

• **Alitalia** has made four flights between Brazzaville and Rome for the Italian government, using DC-6Bs and DC-7Cs. The Italian carrier probably will make additional evacuee flights.

• **Ethiopian Airlines** ferried evacuees from several East African points on special Convair and DC-6B flights to points further north. The Convairs took passengers from Juba, in the southern Sudan, to Khartoum, and the DC-6B flights operated from Entebbe to Brussels. The Ethiopian carrier also moved 300 troops from Addis Ababa to Leopoldville in three DC-6Bs, five DC-3s and a Convair, suspending all scheduled operations, which were resumed last week.

• **KLM Royal Dutch Airlines** has operated at least seven DC-6B and DC-7C flights from the Congo region to Brussels and Amsterdam. One of the flights to Brussels took off from Dar Es Salaam, in Tanganyika territory, and another departed from Nairobi, capital of Kenya. The KLM flights are under Sabena charter.

• **Lufthansa,** under a Sabena contract, made three Super G flights between Brazzaville and Brussels, bringing in food and taking out refugees. Lufthansa also has made several Super G flights for the German government, taking in food and medical supplies and bringing out refugees.

• **Swissair** flew a DC-6B from Zurich to Leopoldville with powdered milk contributed by the Swiss government, and was scheduled to make two additional flights into the Congo with food and out with refugees. The U. N. had requested the Swiss contribution.

Indirect help in handling Sabena's regular routes, stripped of Sabena aircraft, is being provided by other airlines. For example, Alitalia has taken over Sabena's Rome-Brussels schedule; British European Airways provided three special flights for the London-Brussels run.

During early stages of the emergency, which was set off by rioting soldiers of the newly independent republic in the former Belgian Congo, the airport at Leopoldville was shut off to all traffic for about 24 hr. with the rioters in control. Sabena operated principally from Brazzaville during this time.

Soviet Participation

In another development last week, Russia reportedly was joining the airlift with three Il-18 transports en route to Leopoldville and two more scheduled to follow. The Soviets announced that the five planes were provided to ferry Ghana troops to join the U. N. forces. Two of the aircraft were carrying food.

During the airlift operation, a Belgian air force C-119 crashed into a mountain near Goma, reportedly killing 34 Belgian soldiers and injuring seven.

Sabena had hoped to be back in service on the North Atlantic by last weekend, but at midweek the prospect appeared dim. The Congolese cabinet had voted to ask military aid from Russia and other Afro-Asian bloc countries unless the Belgians withdrew all their troops by a deadline. Sabena's return to Atlantic service would depend on whether it could fly troops out of the Congo gradually or would be called on to help move them all at once.

Nevertheless, Sabena hoped to resume Atlantic service some time this week. The airline said its European services already were back to normal.

According to Sabena, its transatlantic service was solidly booked eastbound for the period during which service has been interrupted. Passengers have been accommodated on other transatlantic carriers. Sabena, whose schedules on the route were all-jet, estimates that the seat total through last Saturday was about 4,302 out of New York. Schedules call for two daily round trips, with one 164-passenger all-economy configuration and one 142-passenger mixed configuration.

FAA Extends Installation Deadline For Turbine Transport Recorders

Washington—The Federal Aviation Agency has amended its regulation requiring the installation of flight recorders on all turbine-powered aircraft to give airlines an extra two to eight months to buy and install the equipment (AW May 16, p. 38).

All turbine-powered aircraft weighing more than 12,500 lb. at takeoff, including the Lockheed Electra, Fairchild F-27 and the Vickers Viscount, must carry recorders which can record time, heading, airspeed, altitude and vertical acceleration. They must be installed by Nov. 1, a two-month extension of FAA's original Sept. 1 deadline.

The new regulation permits extension of this Nov. 1 deadline to May 1, 1961, in any case where the carrier submits to FAA written evidence that it will be unable to comply with the regular compliance date because of procurement or installation problems. FAA said extensions also will be granted in cases where the airline can show that it has taken steps to ensure the progressive installation of recorders at the earliest practicable date after Nov. 1.

The amended regulation includes the current requirement that magnetic or aluminum tape recorders be carried on all aircraft of more than 12,500 lb. maximum takeoff weight which are certificated for operations above 25,000 ft. altitude.

Large turbojet transports and piston-engine aircraft operating above this altitude already are required to carry this equipment under Part 41 of the Civil Air Regulations.

The regulation further requires that flight recorders must be operated continuously from the start of takeoff roll until completion of the landing. In the event of inflight failure of the recorder, FAA said the aircraft may continue to the next stop for maintenance repairs. Recorded information must be retained by the airline for a 60 day period or longer if requested for a series of flights by either FAA or the Civil Aeronautics Board.

While FAA noted that it recognized the advantage of allowing the airline industry sufficient time to acquire more complex recorders which would provide both accident data and maintenance information, the agency rejected contentions of many local service airlines that F-27 operations should be exempt from the regulation on the grounds of heavy costs and low altitude operations.

Explaining its stand on the F-27, FAA pointed out that its notice of proposed rule-making stipulated that the regulation was to include all of the new types of high speed, turbine-powered airplanes, "whether certificated to operate above or below 25,000 ft., since they are frequently subjected to similar atmospheric forces."

Air Transport Assn., in its original comments on the proposed rule change, criticized it on the basis of "sketchy" information supplied by the member airlines on their estimated flight recorder installation programs and suggested that FAA delay adoption of the proposal approximately one year.

Lockheed Aircraft Service manufactures a Model 109-C four channel recorder capable of supplying the information required by FAA. The company expects a production rate of 184 units a month on this model by the end of August and also has the marketing rights to the more complex British "Midas" system made by Royston Instruments of England. The multichannel system will be sold in this country under the name of Lockheed Maintenance Recording System, with the first units ready for delivery by November, according to Lockheed.

Other contenders in the bid to supply more sophisticated flight recorders are the Waste King Corp., which has been producing units at the rate of more than 30 a month, and Minneapolis-Honeywell, which expects to have its AG-8 recorder available in December.

CAB Investigating Allegheny Fare Plan

Washington—Allegheny Airlines' plans to to expand its low fare, no reservation service hinge on a Civil Aeronautics Board hearing this week which will examine the airline's 10-month experience with the service in the Philadelphia-Pittsburgh market.

Allegheny recently added the service to routes between Philadelphia-Camden, Boston and Providence. CAB approved the expansion and said it was allowing the new tariffs to become effective because information obtained during the hearing could apply to retention or rejection of the service in either area.

An earlier application by Allegheny, asking that its motion to lift a CAB nonstop restriction between Washington and New York be consolidated in the recessed New York-Short Haul Coach Service Investigation, was denied by the Board. In its application, the airline stated that it proposed to provide "bus type" service on the route if the restriction were lifted (AW May 30, p. 39).

Ticket fares on the no-reservation system are generally 30% below first class fares. Allegheny offers the service for $13 on the 269 mi. Philadelphia-Pittsburgh route. Between Philadelphia and Boston the one-way special fare is $13.64, and between Philadelphia and Providence it is $11.82.

FAA, Airlines Agree On Noise Program

Washington—Voluntary airline acceptance of a standard system of noise abatement procedures for turbojet and turboprop aircraft was announced last week by the Federal Aviation Agency.

Adopted as a result of a joint FAA-airline study of the problem during the past five months, the system will be integrated into present pilot training programs and operational manuals of all airlines.

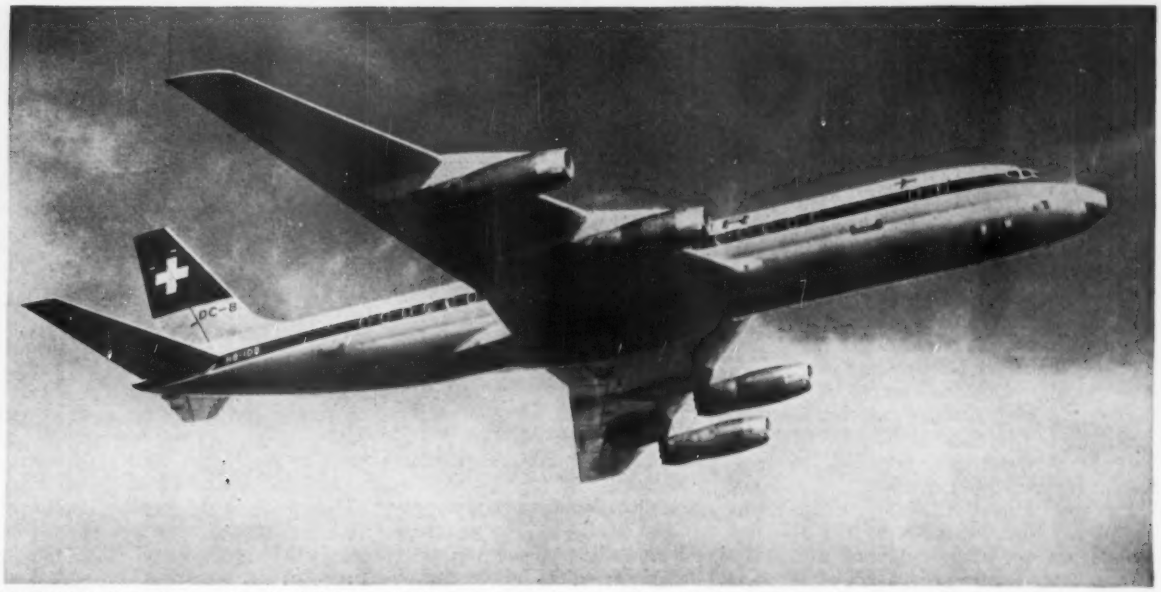
Purpose of the program is to arrive at a set of simplified operating procedures which can be applied on a nationwide basis to reduce aircraft noise levels during takeoffs and landings over heavily populated areas.

Pointing out that there is a "practical limitation" to just how far it can expect to cope successfully with the noise problem by passing new air traffic rules, FAA emphasized that the success of the joint effort rests with the airlines through strict compliance with the new standards.

Ten standard operating factors, covering takeoff, climb straight out, climb turn, approach and landing are outlined by FAA noise abatement formulas for the Boeing 707, Douglas DC-8, Convair 880, Lockheed Electra, Fairchild F-27, Vickers Viscount as well as the Napier Eland-powered Convair 540.

Operating factors formulated by the study are the same in seven categories for all three turbojet transports. They establish a 2,000 ft. altitude under which the noise abatement climb procedures apply on the theory that once this altitude is achieved the noise level is reduced sufficiently. Minimum altitude and degree of bank to turn for the jets is set at 500 ft. and 20 deg.; minimum descent angle is 2.5 deg. and terminal area maneuvering speed limit is set at 200 kt. up to an altitude of 3,000 ft.

Similar standards were established for the turboprops, with a 1,500 ft. altitude limit for climb procedures, a 500 ft. minimum altitude and 20 deg. of turn to bank as a means of avoiding congested areas on takeoff, and a minimum altitude of 1,500 ft. set to commence descent to final approach.



SWISSAIR'S first of three Douglas DC-8s made 13 round trips between New York and Switzerland during first month of operation.

Swissair, SAS Cooperate on Jet Support

By Cecil Brownlow

Zurich—Swissair and Scandinavian Airlines System are jointly weaving a tightly-knit maintenance and training structure designed to permit the two carriers to support the operation of three different jet transport types that can cover all but the shortest stage lengths of their respective route structures.

Basis of the plan is an intertwining "sell, resell" agreement covering two of the three types involved combined with a close liaison program both within and beyond the framework of a six-nation contract that provides for cooperative spare and engine pools for the Douglas DC-8 (AW July 4, p. 45). Here is how the plan—which effectively forms a small, two-nation Air Union—works:

• **Swissair** is receiving four Model 3 Sud Caravelles from SAS for flights over relatively short stage lengths of 400-mi.-plus. All four aircraft are scheduled to be operating over Swissair routes within Europe and to the Middle East by early August. Although legally purchased from SAS and under Swiss registry, SAS has an option to repurchase the aircraft four years after their delivery to Swissair if it chooses. Major maintenance, crew training and provision of most of the spare parts needed for the Swissair Caravelles are the responsibility of SAS.

• **SAS**, beginning in April, 1961, is scheduled to receive two of seven advanced versions of the aft-fan-powered Convair 600 medium-range transport on order by Swissair, complementing these with two others it has purchased directly. Spare parts provisioning, major maintenance and crew training for these SAS and Swissair Convair 600 aircraft—named the Coronado by Swissair (AW Oct. 5, p. 37) and which may possibly be designated the 990 by Convair—will be handled by the latter airline. The two Coronados obtained from Swissair will be legally owned by SAS but, as in the case of the Caravelle, can be repurchased by the original owner after they have been in operation for four years.

• **Swissair and SAS** will operate as a team within the six-carrier agreement to pool spares and engines for the intercontinental DC-8. Under provisions of the over-all contract, each of the six airlines will maintain spares and engine depots at designated terminals from which all the carriers can draw. If, however, Swissair, for example, supplies a Pan American World Airways DC-8 with an engine part from its spares depot at Lisbon, under terms of the six-airline agreement the part must be removed from the aircraft immediately upon its return to New York and air-freighted back to Lisbon. On the other hand, if a Swissair-assigned spares depot installs a part on an SAS DC-8, it remains with the aircraft throughout its useful lifespan. The same applies to an SAS part supplied to Swissair.

The DC-8 cooperation is essentially an extension of the 10-year-old Bene Suisse plan in which Swissair, Sabena Belgian World Airlines and KLM Royal Dutch Airlines pooled spares for their fleets of Convair 240s and 440s and Douglas DC-6s and DC-7s. DC-8s of both carriers are of the same model number and, in an economy move, spares for both airlines will be ordered in a block.

One or more additional European DC-8 operators may soon be brought into the Swissair-SAS pool, with KLM the best bet to become the third participant. Swissair also may push for a wide-sweeping spares pool involving 16 to 17 companies and covering piston-engine aircraft as well as the DC-8, Boeing 707, Caravelle and Coronado during negotiations at the 16th annual general meeting of the International Air Transport Assn. in Copenhagen, Sept. 12-16. Here, however, parts would be issued only on a loan basis since Swissair feels that the possible drain on a small carrier's inventory by a larger airline could be prohibitive.

DC-8 cooperation with SAS also extends beyond the spares pool, with Scandinavian Airlines System assuming responsibility for all but line maintenance on the three aircraft Swissair will have in service by September. Flight training is conducted at Arlanda Airport, a 45-min. drive from Stockholm, primarily because of its remoteness from inhabited areas, whereas the suburbs surrounding Zurich's Kloyten Airport are noise-conscious. The airline's flight training program, however, is under the direction of Swissair instructors.

For its initial service, Swissair is train-

FIRST Caravelle obtained from SAS began service with Swissair May 21. Two Caravelles now fly to London and the Middle East.

ing a total of 44 pilots for the DC-8, with the final group of eight now completing its transition course.

The pilots, most of them transitioning from Douglas DC-7Cs or DC-6Bs, are first sent through a five-week preflight course at Zurich, including 24 hr. in Swissair's Curtiss-Wright-built DC-8 simulator, before reporting to Arlanda for training aboard one of the two aircraft which Swissair now has on hand.

Original flight training syllabus as laid down by the airline called for 12 hr. of flight training. In practice this figure has been trimmed to an average of only 8 hr. Swissair says this has been sufficient for the senior pilots chosen to fly the DC-8.

Spending between four and 10 days in Arlanda, a pilot is taken through the complete flight regime including low-altitude maneuvering, two-engine-out flights and approximately 23 landings, including 11 IFR approaches. The training plane is flown up to 12 hr. a day during which it makes approximately 30 landings.

After Arlanda, the pilot trainee returns to Zurich for additional classroom training and another 12 hr. in the simulator. He then moves directly into the cockpit as either a captain or copilot flying the regular passenger run between Zurich and/or Geneva and New York, making the first three flights with a route check pilot aboard.

As a prelude to the program, six Swissair instructor pilots were sent to Douglas' Long Beach, Calif., plant where they received a total of 11 hr. flying time before going to Arlanda to complete their training under two Douglas flight instructors.

Details of the Swissair-SAS jet cooperation agreement were worked out after the airlines already had begun equipping for the DC-8, and each carrier had purchased a simulator on its own from Curtiss-Wright at a cost of approximately $1.84 million each. Swissair, however, is sharing the SAS-purchased Caravelle simulator located at Bromma Airport near Stockholm and, in turn, is buying a Coronado simulator from Redifon, Ltd., of London, for use by both carriers.

Making maximum use of its DC-8 simulator, Swissair often schedules a class for 5 a. m. and then keeps the equipment in use until 11 p. m., pushing through its own pilots and flight engineers and, under lease, trainees from two French airlines, Transports Aeriens Intercontinentaux (TAI) and Union Aeromaritime de Transport (UAT). In its first five months of operation, the simulator had accumulated a total of 1,153 hr., including 412 hr. for TAI and UAT trainees. Its aircraft are worked almost equally hard.

With one DC-8 in actual service, Swissair is scheduling four round trips a week between Switzerland and New York and plans to boost the number to 12 on Sept. 11 when all three aircraft are placed on the route. The lone Caravelle in service between May 21 and early this month when the second was introduced flew on a schedule of three round trips a day between Zurich and London, with time out every 10 to 12 days for overhaul and maintenance by SAS at Arlanda. (When in Arlanda, the Caravelle flights were taken over by DC-6Bs.)

During its first full month of opera-

FIVE of Swissair's 11 Convair 440s line the ramp at Zurich's Kloten Airport, the airline's home base. The Convairs make 7-8 flights a day on Swissair's short-haul European routes.

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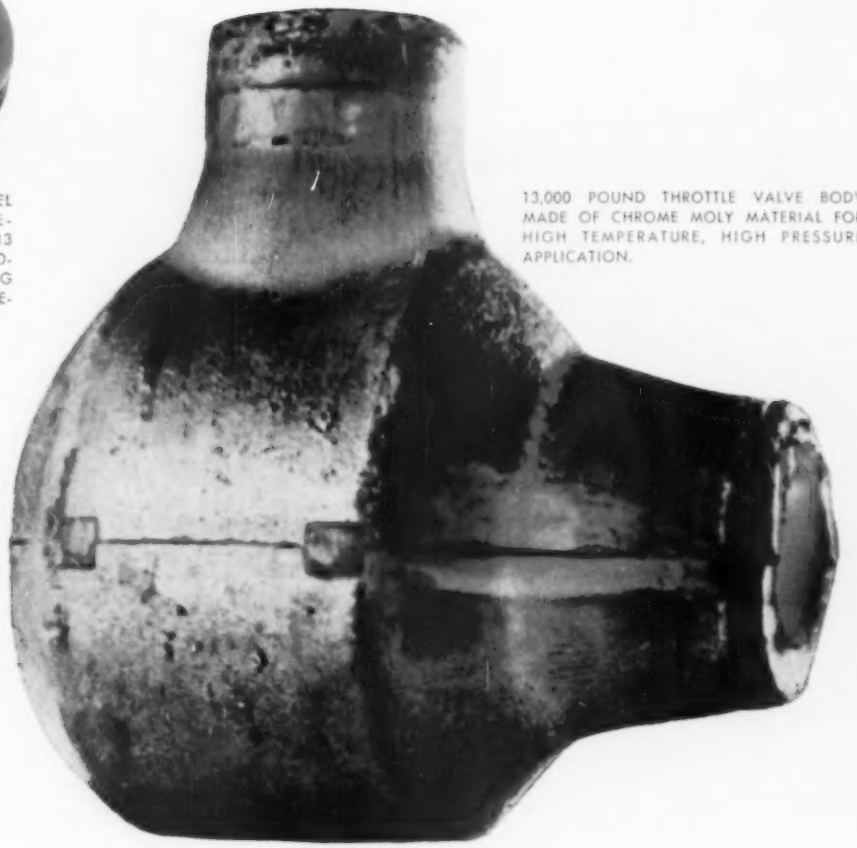

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tion—May 30 to June 30—the DC-8 flew 13 round trips between New York and Switzerland, again with time out for overhaul at Arlanda, with a total of 2,369 passengers.

Configured for 92 economy, 28 first-class seats, the aircraft had an eastbound passenger load factor of 92.9% as opposed to 58.9% westbound and the 55% which Armin Baltensweiler, Swissair executive vice president for planning and research, estimates as the DC-8 breakeven point on the North Atlantic run. It also carried 51,135 lb. of freight and 11,925 lb. of mail for an over-all load factor of 61.9%.

The Caravelle, with 50 economy and 20 first-class seats, carried 7,425 passengers between Zurich and London on 70 round-trip flights during its first month of operation between May 21 and June 21. With its 98,750 lb. of freight and 11,190 lb. of mail, the Caravelle established an over-all load factor of 64.9% for the month.

During its most popular flight of the day—the 11 a.m., 85-min. luncheon run from London, the aircraft established a passenger load factor for the month of 90.4%.

Early this month a second Caravelle was placed in service, with the two aircraft alternating between flights to London and the Middle East on the following schedule:

- **Caravelle leaves Zurich** at 9 a.m. for London, arriving at 10:35 a.m.
- **Aircraft departs London** at 11:30 a.m., arriving in Zurich at 1 p.m.
- **Same aircraft leaves Zurich** at either 2:50 p.m. for Athens or at 2:35 p.m. for Ankara.
- **Second Caravelle** takes off for London at 4:40 p.m., arriving at 6:15.
- **Aircraft leaves London** at 7:05 p.m., arriving in Zurich at 8:35.
- **Second Caravelle** leaves Zurich for London at 9:50 p.m., arriving at 11:25 p.m.
- **Aircraft leaves London** at 1:30 a.m., arriving in Zurich at 3 a.m., and goes into maintenance control to prepare for the 9 a.m. flight to London and, in the afternoon, switching over to the Middle Eastern run. The first plane, meanwhile, returns to Zurich and goes into maintenance control before taking over the 4:40 p.m. flight to London.

All four Caravelles are scheduled to be in service next month with flights to London, the Middle East, Madrid and Scandinavia.

In his training program, a Swissair Caravelle pilot receives approximately 162 hr. of technical instruction on the ground, 14 hr. in the SAS flight simulator and an average of 8¼ hr. in the air, including approximately 21 IFR approaches and 27 landings.

Under present scheduling, Swissair will receive its first Convair Coronado next March, approximately three months before its programed certification time by the Federal Aviation Agency. Both Swissair and SAS will receive one aircraft in April and another in May, with Convair filling out the Swissair order with deliveries in June and July.

Both Swissair and SAS will use the aircraft for the training of flight crews and maintenance personnel pending FAA certification, putting them into service in early July to the Far and Middle East, South America and, for SAS only, South Africa.

Crew training and maintenance for both airlines will remain under the supervision of Swissair, although instruction flights will be made from Arlanda because of the noise problem at Zurich. To help maintain the aircraft, Swissair is establishing a string of 32 spares depots across the Middle and Far East, each stocked with between 10 and 13 General Electric CJ-805-23 aft-fan engines. A similar network for the Caravelle is maintained by SAS, which services the Swissair aircraft at all but one point, Tel Aviv, where a parallel service is not offered by the Scandinavian airline.

To ease the maintenance problem and provide more uniformity for its jet fleet, Swissair also is considering the possibility of eventually converting its Caravelles to the Mark VII configuration, substituting two 16,000-lb.-thrust CJ-805-23s for the present installation of two 11,700-lb.-thrust Rolls-Royce Avon engines.

Once the Coronados are in service with 32 first-class and 64 economy seats, Swissair will pull back its Caravelles from the Middle East to replace its present European workhorse, the Convair 440, on some of the longer routes. Baltensweiler believes that 400 mi. is about the shortest stage length over which the Caravelle can be profitably operated. Swissair may be forced to place the aircraft on shorter runs, however, in order to keep pace with competition from other carriers. Air France, for instance, already is offering Caravelle service on the slightly less than 300 mi. run between Zurich and Paris.

In another move to meet competition, notably Boeing 707 service by Air-India and Air France, and gain an early toehold in the jet market of the area, Swissair may place one of its DC-8 aircraft on its route to the Far East with Tokyo as the terminal point at the end of October when the summer schedule geared for tourist traffic comes to an end and the carrier's jet flights across the North Atlantic are trimmed from 12 round trips a week to nine.

The route is presently served by a Douglas DC-6B which laboriously trudges its way to Tokyo from Zurich in approximately 44 hr., as opposed to the 26 hr. flight with stops planned for the Coronado.

Despite the impact of jet purchase costs and the fact that during most of the year it had to use piston equipment in competition with jet transports on its major routes, Swissair in 1959 realized a net profit of approximately $1.73 million as compared with $1.185 million in 1958, and paid a dividend of 6% to its 10,561 stockholders.

Aircraft utilization for the year averaged 11.1 hr. per day for each of Swissair's 5 DC-7Cs, 9.1 hr. for each of its 7 DC-6Bs and approximately 7.5 hr. for each of its 11 Convair 440s. (Swissair hopes to reach a utilization rate of 10 hr. per day for its jet transports.)

The Convair 440 utilization rate looks particularly good in view of the short stage lengths it generally flies. Here is a typical one-day schedule for a single 440:

- **Geneva to Zurich.**
- **Zurich to Munich.**
- **Munich to Zurich.**
- **Zurich to Paris.**
- **Paris to Geneva.**
- **Geneva to Paris.**
- **Paris to Zurich.**

To maintain such a schedule, Swissair has adopted the blocktype progressive maintenance system and runs its maintenance headquarters in Zurich on a three-shift round-the-clock basis, scheduling as much maintenance and overhaul work as possible for the late night and early morning hours when there is no conflict with flight plans. To a great extent, major overhaul periods are programed for the months of winter and early spring when flight schedules are at their lowest.

Fuel Shortage Cuts Delta's Cuba Payloads

Atlanta—Delta Air Lines DC-7Bs in 72-passenger configuration are carrying only 62 passengers on the carrier's New Orleans to Havana route because of a shortage of aviation gasoline in Cuba.

Shell Oil Co., Delta's prime supplier in Hanava, has advised the airline that it cannot be responsible for what little fuel is available. As a result, Delta flights departing New Orleans are carrying fuel for the round trip and paying the penalty in payload.

By mid-September Delta plans to cut its daily service to Havana to three flights weekly in the face of declining load factors (AW May 23, p. 47). During December, January and February of 1958-59, the peak Cuban tourist season, Delta carrier 1,348 passengers between New Orleans and Havana. Last year, the comparable figure was 704 including only one package vacation trip linked to Cuban government resort promotions.

ALL WE CAN OFFER THE AIR CARGO INDUSTRY IS A PRACTICAL WAY TO MAKE MONEY!

CANADAIR CAN PROVE TO YOU THAT:

YOUR piston powered passenger carrying aircraft now rendered obsolete by new equipment, and being considered for use in cargo operations, or already actually converted can be completely removed from fleet inventory and written down to zero book value in three years;

ONE THIRD the number of Canadair Forty Fours will carry out your cargo requirements at such a profit that they will absorb all expenses incurred in the retirement transaction, plus any earnings your piston engine aircraft would have realized during these three years;

AFTER THESE THREE YEARS, the Forty Four operating profit curve will climb steeply. The difference in profit potential for the following years is substantial.

Any consideration of a specific example requires certain assumptions regarding scheduling, future rates, and load factors, but, under a representative set of conditions our analysis indicates:—that a fleet of 25 piston powered aircraft currently being converted into cargo carriers, could be replaced and retired by a fleet of 8 Forty Fours. The above assumptions and statements are based on the unlikely premise that cargo rates will remain at present levels. If they are reduced, as seems inevitable, the situation will favor the Forty Four even more strongly.

THE FORTY FOUR. The Canadair Forty Four, with its combination of low direct operating costs, high block speeds and large payload capacity, is the world's most economical cargo aircraft. Delivery schedules can be arranged to introduce the Forty Four into airline service fourteen months from contract agreement.

CANADAIR LIMITED, MONTREAL, CANADIAN SUBSIDIARY OF GENERAL DYNAMICS

Soviets Change An-24 Serial Number

Original paint job on the Russian twin-turboprop An-24 transport (AW June 13, p. 39) may have proved embarrassing to Soviet officials. Serial number on the craft was SSSR-L1959 (USSR-L1959), indicating that the craft's factory rollout may have been planned for last year. Within two weeks after the L1959 An-24 appeared, the craft was displayed again with a fancy new paint job—this time with the serial SSSR-L1960. Coincidentally, Aeroflot announced that the An-24 had begun test flights.

Pressure Rising in Soviet Union For Better Airline Ground Service

Moscow—Pressure is rising in the Soviet Union for more vigorous efforts to eliminate the "widening gap" between the quality of flight and ground services in Aeroflot passenger operations.

Construction of ground facilities is lagging, and the attitude of airport personnel remains indifferent to jet-age needs, according to the Soviet press. Russian editors are demanding that terminal accommodations be improved to the point where they match the quality of Aeroflot's fast new transports.

The satirical magazine Krokodil, in an extensive review of ground service shortcomings, notes that the USSR's Seven-Year Plan provides for construction or reconstruction of 90 airports in the 1959-1965 period.

But it said some sharp prods will be required to get this program rolling so that "the ground can be brought up to the level of the sky."

In the air, Krokodil observed, the passenger lives like a king. "Friendly stewardesses feed him meals and treat him to sugar candy. He can enjoy a comfortable seat and read magazines or simply relax.

"However, all this changes when a passenger gets off at a transfer point, or when his plane is unexpectedly delayed at an intermediate station. Our proud air traveler is transformed into a pitiful, forlorn creature who nobody wants.

"There are no accommodations for him to spend the night. There's not even a place to wash up or to sit while he waits for his connecting flight or for the weather to improve so that his plane can continue.

"At the snack bar, the wild and emaciated passenger finds only little patties made of a very popular and very durable building material—ferroconcrete. Nobody can tell the traveler how long he must wait."

Obviously, Krokodil said, the ground gives the air traveler an ungracious reception because it is unprepared to greet him.

"Aeroflot's Central Administration sadly waves its hands in a helpless gesture. It points out that a new transport plane can be built in a matter of days, but five to six years are squandered in construction of a modest hotel or even a checkroom. And by that time the sky has again moved forward; the hotel is once more too small; and the checkroom won't hold the luggage."

Questioned by Krokodil on the lag in airport accommodations, the chief of Aeroflot's Capital Construction Administration said:

"Building personnel obviously believe that construction deadlines are established just to be violated. We should, for example, have completed the airport at Mineralnye Vody last year, but it's still not ready.

"The situation is no better in Moscow. The Main Moscow Province Building Trust is expert at disrupting project schedules. Construction at Kuibyshev Airport has dragged on for over four years."

One of the Russian air traveler's most vexing problems, according to Krokodil, is trying to get correct answers from lackadaisical Aeroflot personnel. "The passenger has to figure out which of 10 pieces of information he receives is right."

To illustrate its point, Krokodil cited the case of "Auntie," who sent a telegram from Moscow to her nephew Aleksei in Rustavi asking that he meet her plane at the neighboring city of Tbilisi. Aleksei reached Tbilisi Airport half an hour before the scheduled plane arrival time, and then, said Krokodil, the runaround began:

"'The Il-14? Oh, it still hasn't left Moscow,' the girl at the information counter told Aleksei with epic calm. Since the flight from Moscow required over six hours, Aleksei returned home to Rustavi.

"As a result, the furious Auntie had no one to meet her at Tbilisi, where she arrived 40 min. later. It seems that her plane was not in Moscow but at Kutaisi (only 100 mi. away).

"The Tbilisi information bureau didn't know this and didn't care to know about it, although it should have been responsible for determining the location of delayed planes. Probably," commented Krokodil, "Tbilisi Airport personnel were busy with more important things—such as discussing advanced methods of passenger service."

The Soviet magazine emphasized that Tbilisi Airport personnel "don't stand alone in the art of passing out misinformation. They have their rivals at Lvov, Rostov, Khabarovsk and other cities, large and small."

Khabarovsk, Krokodil observed, is notorious for assuring passengers changing planes for Magadan that they needn't worry about their baggage—that it will be transferred to the right plane for them.

"But on arriving in Magadan they are told that not even a rumor has been heard about their belongings. The Magadan Airport chief meets each passenger with a mournful wail: 'Khabarovsk again! They lose the baggage, and I'm held responsible.'"

Discussing the situation with Krokodil, Aeroflot Deputy Chief Bashkirov admitted that ground service shortcomings are a major headache:

"But what can we do? We still have rude and indifferent personnel. We are trying to teach them, but obviously our effort in this regard is having poor results."

The world's newest jetliner—the Boeing 720

. . . now flying on United Air Lines routes and soon to enter service with American Airlines, brings jet-travel speed and comfort to more cities. Later the 720 will go into service with Braniff, Irish, Lufthansa and Western air lines.

The superb 720 operates easily from shorter runways, yet cruises at more than 600 miles an hour. It's sleek, roomy and wonderfully comfortable . . . with the exceptional passenger appeal demonstrated by Boeing jets in service.

BOEING 720

Airline Income & Expenses—May, 1960

(IN DOLLARS)

DOMESTIC TRUNK	Passenger Revenue	U. S. Mail	Express	Freight	Charter	Total Operating Revenue	Total Operating Expenses	Net Income Before Taxes
American	31,506,043	625,318	347,272	1,984,253	.....	34,913,610	33,836,763	1,076,847
Braniff	5,991,002	184,780	63,435	193,472	15,188	6,518,996	6,224,954	173,782
Capitol	8,185,462	205,085	121,358	132,543	23,778	8,772,738	9,482,731	−709,993[3]
Continental	4,615,000	76,000	43,000	90,000	5,000	4,930,000	4,460,000	177,000
Delta	9,529,000	179,000	114,000	346,000	38,000	10,420,000	9,456,000	792,000
Eastern	19,907,509	446,971	908,507[2]	.....	7,940	21,364,537	23,371,308	−2,018,025
National	4,292,519	97,659	22,301	178,694	55,806	4,744,609	5,847,739	−1,197,130
Northeast	2,678,891	39,728	23,656	77,357	.....	2,893,809	3,435,821	−542,012[3]
Northwest	5,939,828	212,509	520,109[2]	.....	10,350	6,718,871	7,253,278	−657,992
Trans World	20,862,349	478,212	1,163,603[2]	.....	111,226	22,786,629	23,514,378	−1,256,180
United	25,089,266	972,096	2,076,246[2]	.....	29,058	29,385,774	28,211,639	1,449,053
Western	4,251,896	102,716	196,834[2]	.....	49,114	4,616,182	4,485,616	83,720
INTERNATIONAL								
American	407,799	8,228	125	54,292	.....	493,476	594,513	−99,037
Braniff	820,900	19,412	.....	51,061	.....	946,748	950,406	−21,252
Caribbean & Atlantic	253,758	3,042	14,014[2]	.....	2,100	278,214	257,996	20,429
Delta	276,000	4,000	.....	8,000	.....	301,000	374,000	−75,000
Eastern	2,284,661	61,281	94,026[2]	.....	28,911	2,471,972	2,421,180	12,502
Mackey	134,339	.....	735	3,508	.....	147,546	159,289	−11,743[3]
National	79,897	904	577	2,006	11,634	98,693	180,503	−81,810
Northwest	1,916,456	582,434	391,613[2]	.....	49,341	3,028,508	3,020,348	−29,700
Pan American Combined	27,015,000	1,710,000	.....	3,355,000	658,000	33,975,000	31,421,000	2,132,000
Alaska	440,000	17,000	.....	46,000	.....	520,000	451,000	57,000
Atlantic	13,116,000	702,000	.....	1,267,000	418,000	15,950,000	13,978,000	2,022,000
Latin America	5,684,000	201,000	.....	1,047,000	224,000	7,606,000	9,279,000	−1,421,000
Pacific	7,775,000	790,000	.....	995,000	16,000	9,899,000	7,705,000	2,237,000
Panagra	1,073,000	54,000	.....	193,000	.....	1,473,000	1,742,000	246,000
Resort	.....	.....	.....	.....	415,286[1]	417,057	406,257	10,800[3]
Trans Caribbean	446,005	.....	49,855[2]	.....	41,033	559,108	570,572	20,619
Trans World	8,715,190	597,649	608,378[2]	.....	227,089	10,443,846	7,363,546	3,081,195
United	1,673,834	47,258	44,783[2]	.....	.....	1,774,956	7,208,638	534,250
Western	389,424	5,597	14,056[2]	.....	.....	410,139	370,094	35,319
LOCAL SERVICE								
Allegheny	844,754	9,266	15,710	25,650	2,599[1]	1,194,084	1,246,340	−52,256[3]
Bonanza	348,496	7,404	2,432	6,793	8,060	573,699	639,045	−84,910
Central	209,086	7,750	1,896	7,632	418	464,293	489,085	−24,793[3]
Frontier	496,550	13,820	5,000	27,538	9,185	1,083,880	1,139,144	−69,087
Lake Central	252,754	6,677	9,298	.....	1,289	421,764	407,401	14,364[3]
Mohawk	765,057	12,696	7,481	13,519	14,273	986,344	1,057,571	−71,227[3]
North Central	1,046,998	32,433	19,000	23,157	−564[1]	1,658,333	1,799,759	−138,393
Ozark	661,608	12,371	23,181	19,161	1,713	1,014,313	1,070,836	−56,523
Pacific*	.....	.....	.....	.....	.....	.....	.....	.....
Piedmont[5]	639,746	10,062	6,522	10,108	17,046[1]	1,024,087	1,040,848	−43,252
Southern	414,727	16,050	6,348	12,313	2,508	676,440	727,893	−54,713
Trans-Texas[5]	445,986	23,728	5,873	16,796	14,702	750,544	728,839	20,980
West Coast	514,978	8,655	2,428	2,384	2,258	858,080	958,018	−99,938[3]
HAWAIIAN LINES								
Aloha	351,569	2,038	.....	7,022	248[1]	367,690	404,688	−36,998[3]
Hawaiian	505,464	3,851	.....	71,673	307,894	902,454	923,240	−43,655
CARGO LINES								
AAXICO	.....	.....	.....	.....	970,014	1,051,515	742,835	308,835
Aerovias Sud Americana	.....	.....	.....	110,314[4]	134,449	244,805	233,097	11,708[3]
Flying Tiger	.....	17,240	1,054,380[2]	.....	457,136	1,503,570	2,043,981	−604,351
Riddle	.....	.....	.....	431,507	.....	433,862	594,348	−160,485[3]
Seaboard & Western*	.....	.....	.....	.....	.....	.....	.....	.....
Slick	.....	.....	.....	.....	1,098,528	1,138,135	1,144,923	−6,788[3]
HELICOPTER LINES								
Chicago Helicopter	177,308	135,898	.....	.....	.....	313,286	290,198	21,207
Los Angeles Airways*	.....	.....	.....	.....	.....	.....	.....	.....
New York Airways	90,649	5,461	3,612	3,292	.....	293,108	309,160	−22,790
ALASKA LINES								
Alaska Airlines	221,798	63,361	2,163	52,628	193,107	676,820	659,007	−27,478
Alaska Coastal	106,656	11,013	.....	10,882	4,574	182,478	192,082	−9,604[3]
Cordova	15,124	8,835	.....	9,009	40,375	104,161	101,824	−1,041
Ellis	77,300	5,000	8,100[2]	.....	2,000	121,500	114,600	6,900[3]
Northern Consolidated	90,840	50,547	.....	31,313	11,421[1]	237,627	260,101	−22,476[3]
Pacific Northern	683,052	55,727	2,209	95,190	2,086	1,000,529	973,720	9,956
Reeve Aleutian	173,375	34,437	.....	31,186[7]	20,645	261,130	183,799	73,285
Western Alaska[6]	13,720	5,495	.....	3,339[7]	3,765	48,207	39,919	−20[3]
Wien Alaska	90,116	60,115	.....	32,926	55,744	793,045	379,813	413,252[3]

[1] Non scheduled transportation [2] Property figure [3] Operating profit or loss [4] Common carriage [5] Airline division figures [6] Feb. 27, 1960, to May 31, 1960 [7] Freight & excess baggage — Minus figure * Not available

Compiled by Aviation Week from airline reports to the Civil Aeronautics Board.

BUMPER 8, JULY 24, 1950

ATLAS "LONGFELLOW," 1960

FROM THE EXPERIMENTAL BUMPER IN 1950 TO THE ATLAS IN 1960 . . .

CAPE CANAVERAL'S FIRST 1(

Just ten years ago yesterday, the first experimental missile was fired from Cape Canaveral. Here, General Electric reports on this key U.S. missile and space research center's first ten years of progress.

A few men, a quickly constructed wooden "command post" and the firing of a hybrid Army Wac Corporal/V-2 missile called BUMPER 8 . . . this was the beginning ten years ago yesterday of what today is the largest missile test center in the world: Cape Canaveral.

AS BUMPER 8, developed under General Electric systems management, climbed away from the then Long Range Proving Ground Division, the only horizon-breaking landmark was a lighthouse tower near a cluster of homes. Today, this scene has been dramatically changed with miles of hard top roads leading to hundreds of launch sites, test centers, hangars, fuel supply areas and block houses.

Behind this changed scene lies a record of more than 800 successful launchings that have been conducted by the three U.S. military services and other government agencies working with Air Force Missile Test Center personnel who maintain and operate "the Cape," or Station One of the Atlantic Missile Range and the islands "downrange."

AMERICA IS ACHIEVING IMPORTANT MILITARY AND SCIENTIFIC PROGRESS FROM CAPE CANAVERAL MILESTONES LIKE THESE . . .

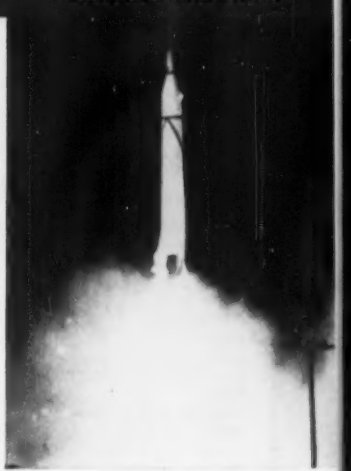
FIRST CAPE LAUNCH

Wac Corporal/V-2 missile called BUMPER 8 was fired by handful of Army and G.E. personnel on July 24, 1950. It provided vital data as basis for early missile progress.

X-17 THREE STAGE MISSILE

First fired in July, 1956, Air Force X-17 re-entry test vehicle was designed to achieve high re-entry velocity and yielded important information relative to ballistic flight problems.

EXPLORER I SATELLITE



This nation's first satellite was launched on January 31, 1958 from the Cape and is still in orbit. Army Jupiter-C booster placed this historic satellite into orbit around the earth.

YEARS OF MISSILE AND SPACE PROGRESS

These launchings have paid immeasurable dividends. In the area of U.S. missile progress, Cape Canaveral test launchings have led to the present operational status of Thor, Atlas, Jupiter, Snark and Matador, and are now speeding the development of Polaris and Titan.

In the area of space technology, missile test flights from the Cape have proved the reliability of U.S. ICBM re-entry vehicles and the accuracy of U.S. ICBM radio command guidance, provided information on the belt of radiation around the Earth and other valuable data about space environment and flight that will serve scientists in their efforts to conquer space.

In satellite progress, the successful launchings of Pioneer, Explorer, Transit, Tiros and other satellites from the Cape have paved the way for a whole new generation of orbiting bodies that will aid in communications, navigation, weather forecasting and in the protection of the Free World.

This progress has truly been the result of team effort. The military services and government space agencies together with companies like General Electric . . . a member of the Cape team since its Bumper 8 missile beginning . . . have made vitally important contributions. General Electric, its Defense Electronics Division and the Defense Systems, Heavy Military Electronics, Light Military Electronics, Missile and Space Vehicle, and Ordnance Departments that are a part of this Division are proud to be members of this team and contributors to this progress.

A unique 15 x 19-inch four color illustration, suitable for framing, of the historic first missile launching from Cape Canaveral is available upon request from General Electric Company, Section 160-88, Schenectady, N. Y.

DEFENSE ELECTRONICS DIVISION

GENERAL ELECTRIC

FIRST PAYLOAD RECOVERY

First payload, a re-entry vehicle data capsule, to be recovered from space was launched by USAF Thor missile in 1958. G.E. built both re-entry vehicle and capsule.

FIRST ABLATION ICBM CONE

First ablation re-entry vehicle to fly full ICBM range was developed by G.E. and launched on July 9, 1958 . . . proved feasibility of ablation for ICBM re-entry.

FIRST POLARIS SHIP LAUNCH

First Polaris shipboard launch was made from Navy's USS Observation Island on August 27, 1959. G.E. is producing Polaris fire control and inertial guidance systems.

LONGEST MISSILE FLIGHT

USAF Atlas with G.E. radio command guidance and re-entry vehicle launched this May flew more than 9000 miles . . . longest Free World missile flight recorded to date.

AIRLINE OBSERVER

► Capital Shareholders Assn., employe-stockholder group seeking to overturn present management of Capital Airlines, has endorsed six of the 14 members of the company's current board of directors. Endorsement includes Board Chairman Thomas Needlands, Jr. and Gordon Y. Billard, who also is head of the Debenture Holders Protective Committee. The association also gave its support to members James R. Stockton, C. Bedell Monro and Raymond G. Lochiel. It took no position on the re-election of Charles Murchison or George Hann on grounds that their share holdings were sufficient to ensure their re-election.

► Mohawk Airlines wants to take over the route between Elmira, N. Y., and Washington which Capital Airlines wants to drop (AW July 18, p. 43). Mohawk has told the Civil Aeronautics Board it wants the route and would add Utica-Rome and Ithaca to it. The carrier also suggested that Allegheny Airlines serve Capital's present route from Washington to Buffalo via Williamsport and Harrisburg, Pa.

► Air France now is offering fly-now-pay-later flights. Under an agreement with Credit Lyonnais, French state-owned bank, the credit plan covers not only the cost of the flight but also hotel costs, car rental fees and other incidental expenses. Initial deposit is 10%, with up to 12 months to pay the balance. Interest rate is 5.5%.

► Federal Aviation Agency has awarded contracts to the Hazeltine Technical Development Center and Wilcox Electric Co. for the development of radar beacon transponders for use by business and private aircraft. Final models will weigh about 14 lb. and will cost, under production, about $1,000.

► Czechoslovak Airlines is using Russian-built Il-18 turboprop transports on its route between Prague and Baghdad via Athens and Damascus.

► Braniff Airways and Eastern Air Lines began interchange service last week between New York and Bogota, Colombia, via Miami and Panama with Braniff's Boeing 707-220 turbojet equipment. Braniff will fly the aircraft on the Miami-Bogota segment of the route, Eastern on the Miami-New York leg.

► Ethiopian Airlines has signed a letter of intent to buy two Boeing 720B turbofan transports for delivery in December, 1961.

► Delta Air Lines is now operating an all-jet schedule out of New York's International Airport. The airline is offering 10 schedules daily using Douglas DC-8 and Convair 880 turbojet transports.

► Mohawk Airlines will equip its five Convair 440s and seven Convair 240s with RCA AVQ-50 weather radars. Installation begins this month, will be completed by January, 1961.

► Civil penalties totaling $1,400 have been paid to the Federal Aviation Agency by seven passengers charged with violating regulations prohibiting drinking from private liquor supplies aboard scheduled transports (AW June 13, p. 49). FAA assessed a $200 compromise penalty for each violator. Fines can be as high as $1,000.

► Development Loan Fund will lend the government of Chile $10.5 million for the construction of an international commercial jet airport at Santiago. Airport plans call for a 10,500 ft. runway designed for single wheel loads of 62,500 lb.

► Ansett-A.N.A., Australian airline, has ordered two Fokker F-27 Friendship turboprop transports to bring its Friendship fleet up to to a total of eight. Delivery is scheduled for early 1961.

► Original Boeing 707 turbojet prototype, the "dash eighty," which celebrated its sixth anniversary on July 15, is still being used extensively in the 707 series product improvement program. Plane now is undergoing a heavily instrumented program of investigating various high lift devices.

SHORTLINES

Air Transport Assn. has revised its "Standard Method of Estimating Comparative Direct Operating Costs of Transport Aircraft." Latest edition is the third revision of the report, which was first published in 1944.

Air Line Pilots Assn. has filed a suit in Federal District Court in Chicago asking that Federal Aviation Agency be restrained from displacing third pilots with FAA inspectors on turbojet flights. Suit was filed as a cross-complaint growing out of an injunction obtained by American, Pan American and TWA requiring pilots to accept flights on which the third pilot was displaced.

► **Alitalia**, the Italian airline, has introduced its third Douglas DC-8 turbojet transport on its transatlantic route, increasing jet flights to a daily service between New York and Rome. Carrier plans to have an all-jet service on the route by Aug. 1, with 11 flights weekly.

► **Air France** has been named general agent in North America for Transports Aeriens Intercontinentaux–TAI. Air France will handle all the privately-owned carrier's sales, traffic and promotional activities in the U. S., promoting TAI's Los Angeles-Tahiti route and the around-the-world route operated by connecting services of the two companies.

► **American Airlines** and Continental Air Lines will begin Boeing 707 turbojet transport service between Los Angeles, El Paso and Houston Sept. 25. Under the interchange agreement, flight equipment will be supplied by Continental in the first six months of the service and by American during the second six month . American crews will fly the schedules between Los Angeles and El Paso, with Continental crews flying over the balance of the route.

► **Independent Airlines Assn.** will request CAB permission to enable its member airlines to provide year-round transatlantic charters for $21,978 in Lockheed Constellation equipment. Passenger's round-trip fare would average $222.

► **Pan American World Airways** will begin Boeing 707-320 turbojet transport service from New York to Rio de Janeiro Aug. 3. Flight time on the 4,872-mi. trip, which includes a 45 min. stop at Trinidad, will be 9 hr. 45 min.

► **Panagra** has introduced a Douglas DC-7 all-cargo service from Miami to Guayaquil, Lima, La Paz and Cochabamba on a weekly schedule. The service replaces a DC-6A all-cargo operation started earlier this year.

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This new refueler holds 8000 gallons of AeroShell Turbine Fuel . . . the industry-wide choice for the exacting requirements of jet flying.

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MEMO TO MICHAEL:

Your recent letter to the company has been brought to my attention. I am particularly interested in this paragraph,

I am in the fifth grade at Braun School and am very interested in aviation. When I grow up I want to be a aeronautical Engineer if my mother will let me

**

Michael, I certainly hope you keep your desire to make a career in aviation. In my opinion it is one of the most challenging opportunities for the young men of America. The helicopter industry, and aviation in general, is helping to keep our country strong and we look forward to the help that boys like you can give when your time comes. The backbone of the aircraft industry is the engineer. We will always need good engineers with imagination and vision. You have that vision now. Please keep it. I'm sure that you can count on your mother's support when you are ready to take your place among the other young men who are playing a vital role in a vital industry.

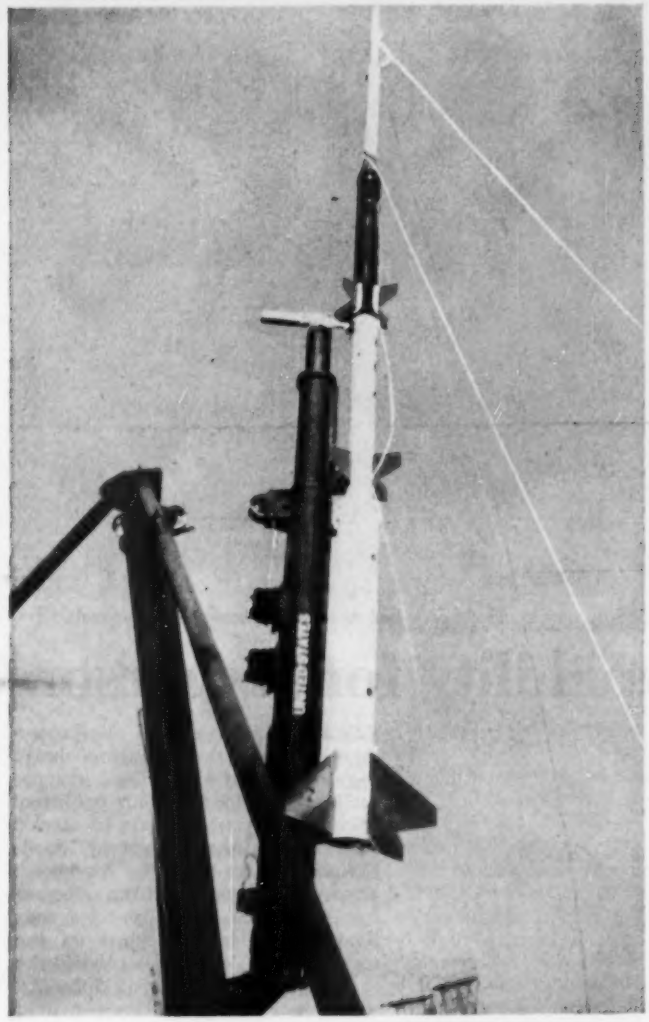
Sincerely,

Charles H Kaman

. . . IN NATIONAL DEFENSE

KAMAN IS PART OF THE PLAN

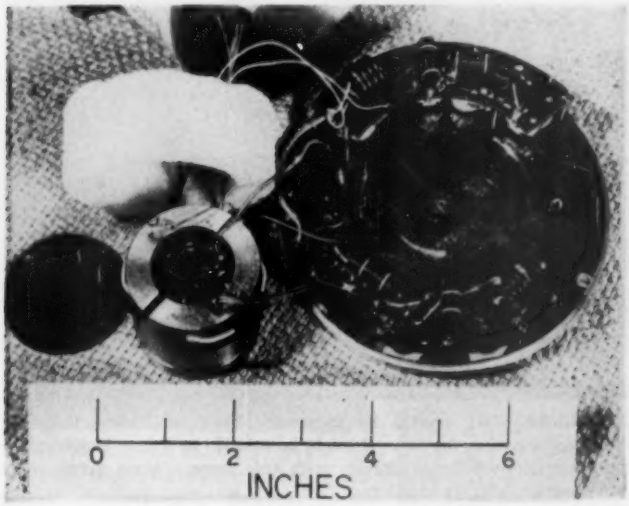
**Facsimile of a letter to the company

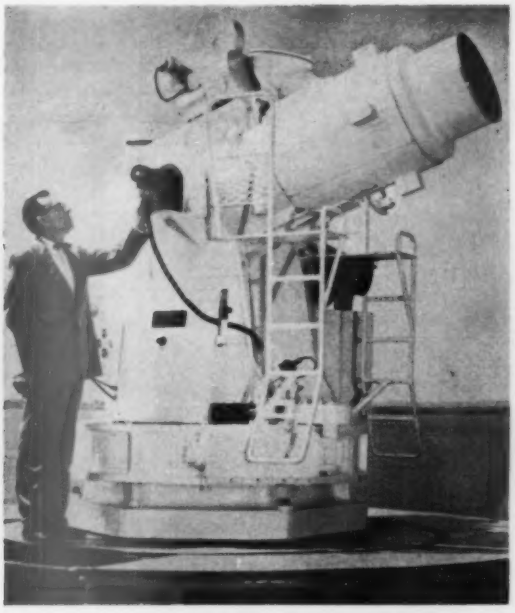


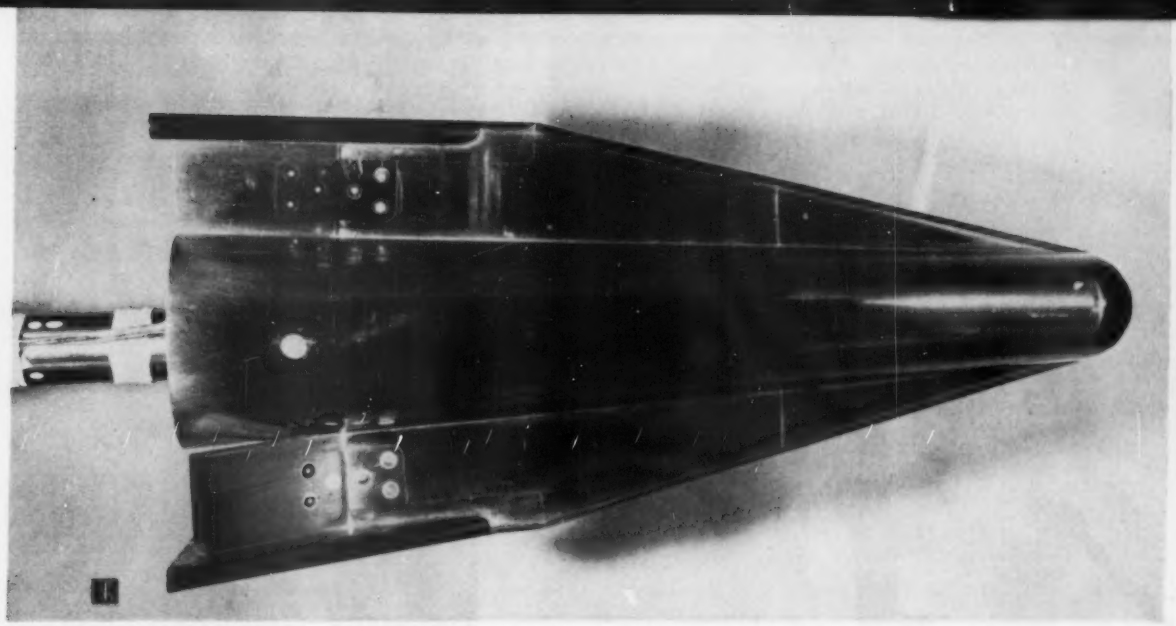
Strongarm sounding rocket is being fired at Wallops Island, Va., in a series of ionospheric electron density experiments which began last fall. Army Ballistic Research Laboratories rocket (left) is composed of Honest John first stage, Nike Ajax booster second and third stages, modified Recruit fourth stage and scaled-down Sergeant last stage. Teflon-covered ablative nose cone (top) carried 37 and 148 mc. transmitters in its circular base, with internal structures acting as antennas. Circular objects at tip and center of nose cone are antenna tuning capacitors. BRL developed SPORT system (below) to track and photograph the flight.

Strongarm Launched to Ionosphere For Electron Density Measurement

Radio transmitter in Strongarm payload included 37 and 148 mc. amplifiers (right) and a master oscillator (second from left).







CONFIGURATION ABOVE resembles the one chosen for the Dyna-Soar vehicle and the early Bell Aircraft hypersonic glider proposals.

USAF Builds Capability for Hypersonic

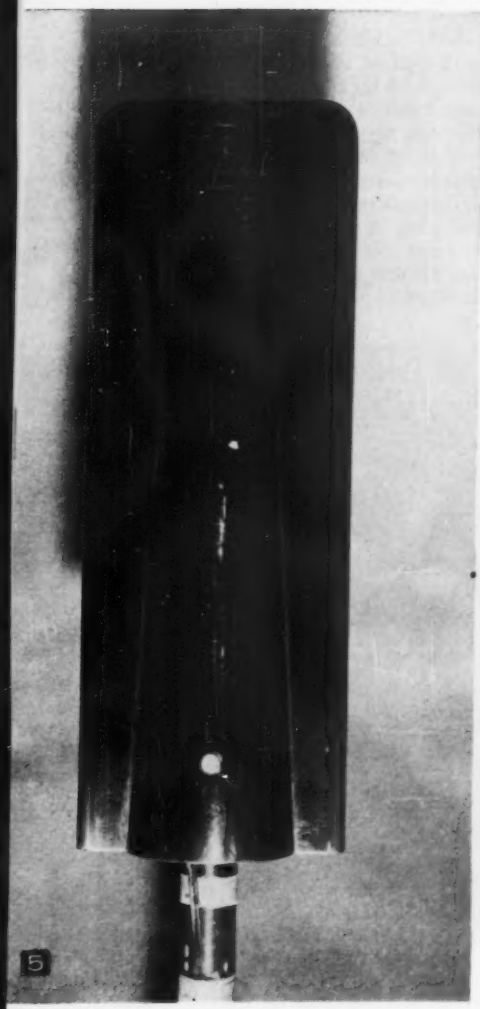
By J. S. Butz, Jr.

Washington—Air Force has created a capability to manage the technical development of winged hypersonic vehicles, primarily by playing a major role in compiling the necessary engineering design data through study contracts and internal applied research programs.

Air Force's primary purpose in developing across-the-board competency in this field is to allow a complete return to the traditional Air Force-contractor relationship without the technical middleman which are required during the development of ballistic missiles.

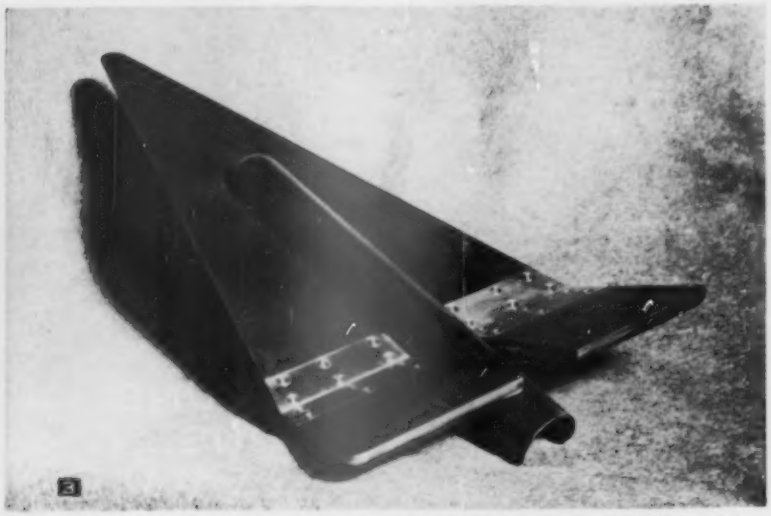
The traditional relationship in which technically competent Air Force personnel supervise the contractors' design and development work on new weapons has been abandoned in only one major instance—the crash program to develop large ballistic missiles. Ballistic Missile Division was set up as the Air Force's management agency for this program, and its technical advice came first from Ramo-Wooldridge and then its successor, Space Technology Laboratories.

National Aeronautics and Space Administration and several research foundations and universities currently are making major contributions to the understanding of hypersonic aerodynamics and heated structures without direct Air Force support. But many such organi-



VARIETY OF CONFIGURATIONS studied for hypersonic flight is illustrated by the constant-span shovel-nosed model at the left. It might be possible to reduce high-temperature area at the expense of poor lateral stability with this shape. Many arrow wings (above) have been tested.

MODELS of hypersonic vehicles are tested at very high angles of attack.

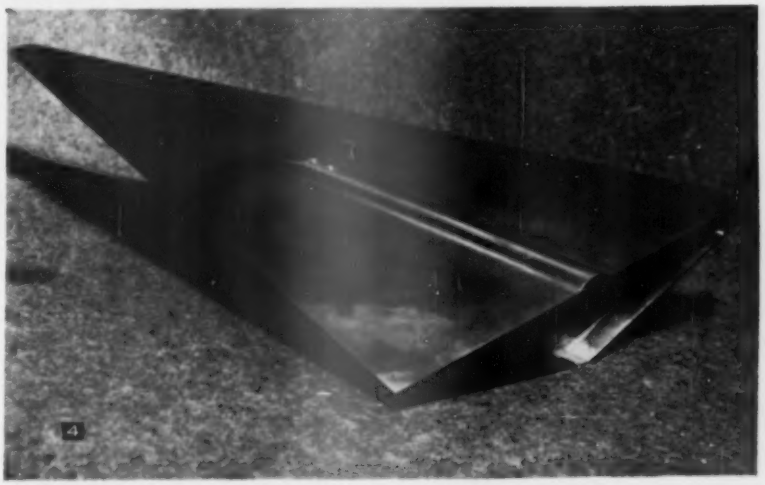


EFFECTIVENESS of control surfaces on hypersonic boost glide vehicles is one of the subjects of the Air Force-Lockheed study of very high-speed aircraft configurations.

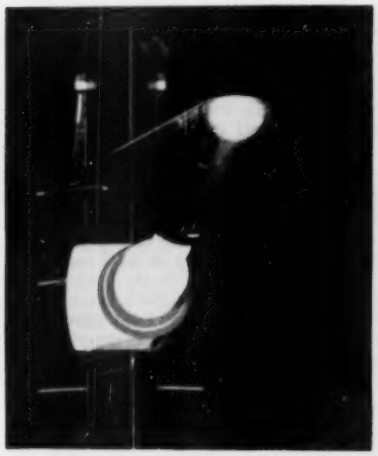
Development

zations also are assisting the USAF effort by developing design manuals for hypersonic aircraft under contract.

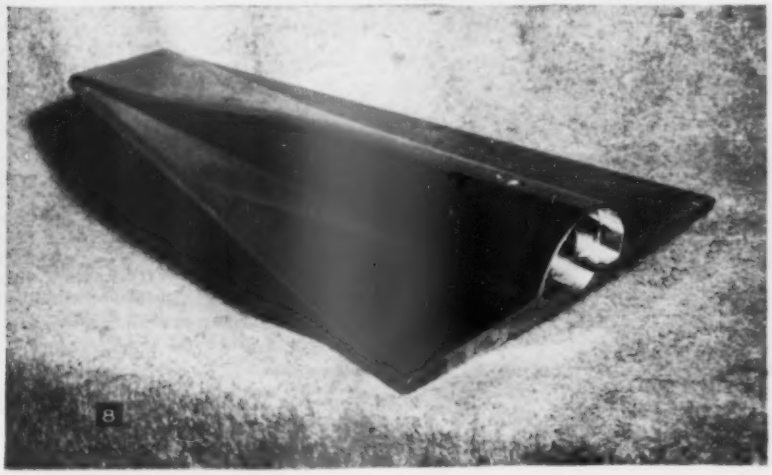
Wright Air Development Division is the Air Force group charged with technical management of the Boeing Dyna-Soar orbital aircraft which is now under development. This division is also the Air Force's management agency for advanced hypersonic systems which are still in the preliminary and conceptual design stages. To perform this advanced design function, WADD is sponsoring a wide variety of internal and contract applied research programs intended to give the organization an in-house capability to perform the complete preliminary design job for winged and manned hypersonic vehicles. This in-



POSITIVE DIHEDRAL on a hypersonic wing (model No. 4) gives vehicle a "vee" bottom appearance. This increases the internal volume, reduces stresses in the wing and transfers the location of maximum heating from the wing leading edges to the ridge along the center of the lower surface. Shovel nose (model No. 8) has been investigated for possible improvement in lift/drag ratio.



INCREASE in nose bluntness lowers the maximum temperature on a vehicle at the expense of aerodynamic efficiency.



Nerve Centers For A Satellite

Over 25,000 informative cloud-cover pictures have been received from TIROS I since it was launched on April 1. In two months the satellite had completed 1000 orbits and travelled 27,500,000 statute miles. This means not only that TIROS itself has performed as planned, but that the complex problems of command and control, as well as signal reception and processing, have been successfully surmounted. Like the satellite, the special ground station equipments were designed and built by RCA Astro-Electronics Division under the auspices of NASA and technical direction of the U.S. Army Signal Corps.

Major components at each of the four ground stations include:

- Five TV receivers and four beacon receivers used in diversity reception to minimize signal fading
- A programmer which pre-programs different combinations of operating modes, and a 200 watt command transmitter
- A TV monitor to display the picture signal for the automatic recording camera. The camera is equipped to make either positive or negative films
- An indexer and sun angle computer which generate an index number and sun angle indication for each picture, used for geographical orientation
- An attitude recorder which picks up the earth-horizon signal for spin axis position computation
- Two standard 4-channel tape recorders to back up the monitor
- Two paper recorders to monitor forty telemetered satellite parameters
- An antenna programmer which directs the antenna to follow the orbit of the satellite when it is in range of the ground stations

All program functions are timed by a master clock which is synched to standard time signals from WWV. In addition to normal picture direct transmission and record functions, the programmer can also command spin-up. After two months the spin rate had decreased to 9.4 rpm's due to the effect of the earth's magnetic field. On command from the ground, two solid propellent spin-up rockets on the satellite were fired, increasing the spin to 12.8 rpm's.

AED's own ground station was used to process photos from the magnetic tapes for the first one hundred orbits.

The integrated design and development of these TIROS ground stations is an indication of AED's capability in *total satellite systems*. This capability will become increasingly critical as more and more complex satellites and space probes are launched to advance man's understanding and control of his universe. To discover how you can draw on this broad R & D experience, contact the Marketing Manager, RCA Astro-Electronics Division, Princeton, N. J.

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house design capability is regarded as the key to good technical management.

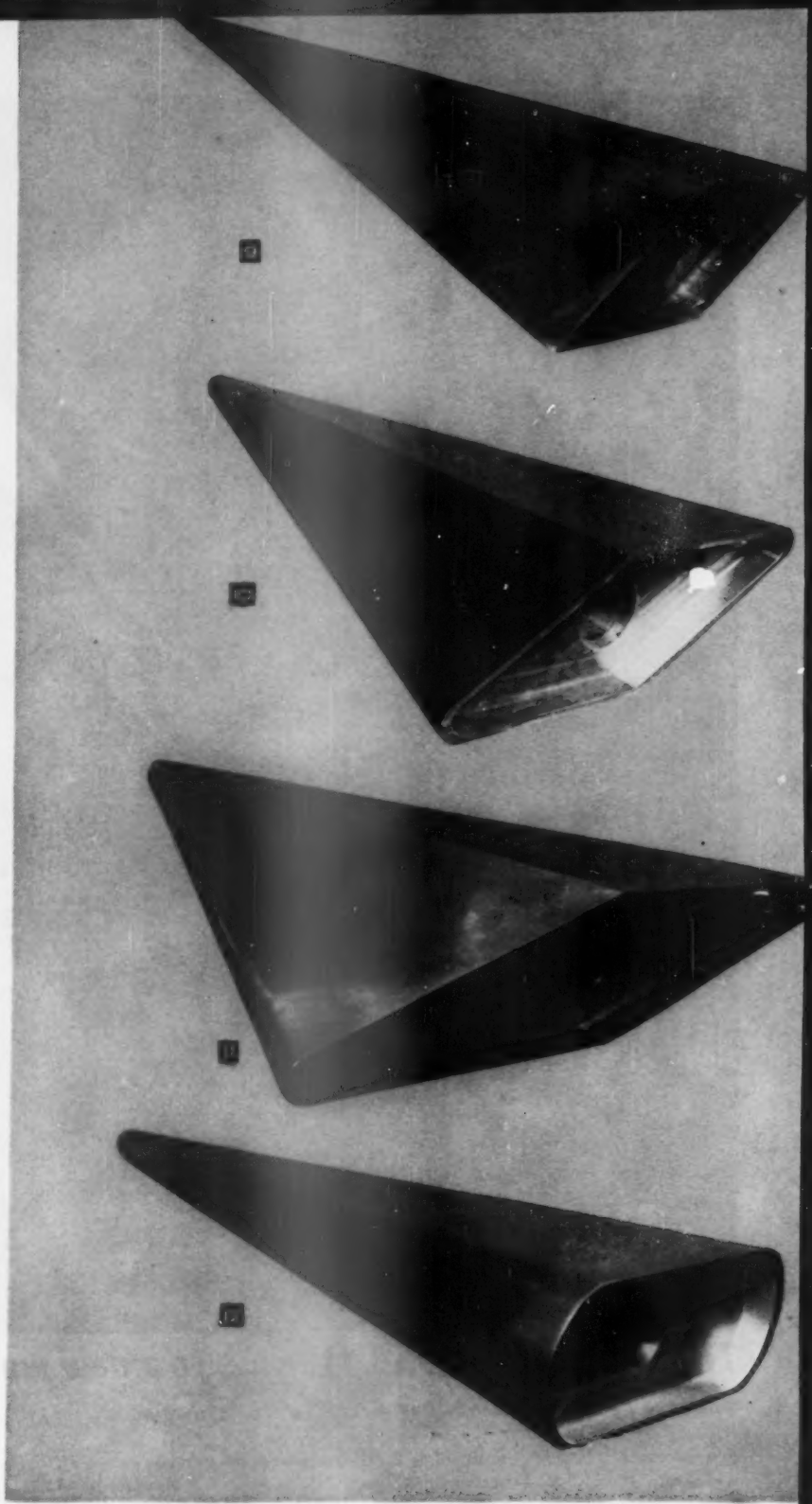
Aircraft and airborne missile programs are directed by WADD, which is supposed to perform management functions and provide technical support. Management of these programs is handled by WADD's Directorate of Systems Management, and its Directorate of Systems Engineering is the technical advisory group. Dyna-Soar development is being managed by these offices, as is the B-70, GAM-87A Skybolt air-launched ballistic missile, the GAM-72 Green Quail decoy missile and all of the other Air Force weapons in development as airborne systems.

The third major WADD subdivision, the Directorate of Advanced Systems Technology, is the group which must be competent to judge the state of advanced technologies and has been directed to maintain a capacity for the complete preliminary design of winged hypersonic vehicles. An especially close interchange of information between the three directorates is maintained in the case of the Dyna-Soar program, which is just out of preliminary design and will provide more concrete information on hypersonic vehicles after it has made a few flights than all of the research performed to date.

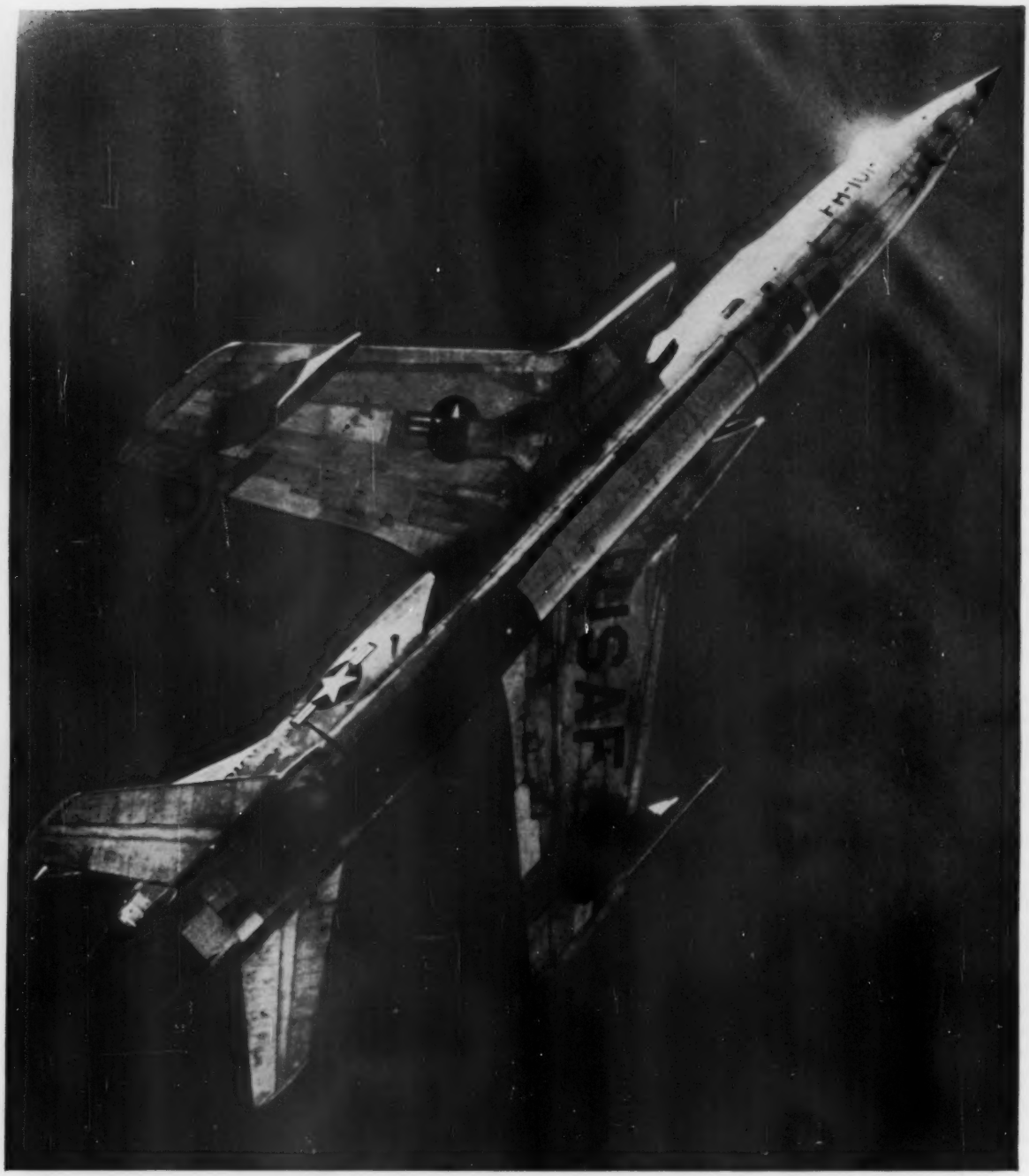
Typical of the applied research programs supported by the Directorate of Advanced Systems Technology are these six:

• **Hypersonic configurations** study by California Division of Lockheed Aircraft Corp. Objective of this study is a design manual containing analysis techniques for predicting the aerodynamic characteristics of hypersonic vehicles over a large speed range. Theoretical portion of this study is complemented by about 500 hr. of wind tunnel test in the Von Karman Gas Dynamics Facility at the Arnold Engineering Development Center over a Mach number range from 2 to 18.

• **Study of flow characteristics** around a lifting body during re-entry into the atmosphere is being conducted by General Applied Sciences Laboratories, Westbury, N. Y. Main problem in this study is concerned with the effect of the hot boundary layer flow near a body on the external free-stream flow outside of the boundary layer. This effect is of special importance in determining the flow interference between two or more bodies on a hypersonic vehicle such as the wing, fuselage and stabilizing fins. Experimental portion of this study is being conducted in AEDC facilities in the Mach 8 to 25 range. Ultimate objective of this study and many others of a similar nature which are supported by WADD is a simple design manual which will allow aerodynamic heating and pressure distribution over a hypersonic vehicle to



WIND TUNNEL TEST DATA from the family of models above can be used to determine the effect of leading edge bluntness on the aerodynamic and heating characteristics of hypersonic vehicles. Model No. 9, with very sharp leading edges, represents one extreme, while the large rounded wing leading edges on model No. 12 have about the maximum curvature which would be considered on a practical vehicle. Test data on this family of models will also contribute to the study of dihedral effects. Wings shown above are only a small portion of those tested at Tullahoma.



The Republic F-105D streaks to a new world speed record...

powered by a Pratt & Whitney Aircraft J-75 jet engine

On December 11, 1959, the Republic F-105D fighter-bomber raced over the Mojave Desert at 38,000 feet. The course was a 62.4 mile circle. With a temperature of 63 degrees below zero, the Air Force F-105D whipped through the closed-course flight to establish a new world's record of 1,216.48 mph.

Its highly advanced electronics, radar, and associated equipment, enable the F-105D to perform missions at twice the speed of sound regardless of visibility, ceilings, or target area conditions. Its speed and power make it one of the most versatile aircraft in history.

The jet engine that powers the F-105D is the Pratt & Whitney Aircraft J-75. This same engine also powers Convair's F-106 all-weather interceptor which recently set a new world's straight-away record. Over the years, the Pratt & Whitney Aircraft J-57 and J-75 jet engines have broken virtually every major flight record.

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be predicted rapidly with the engineering accuracy used today for supersonic aircraft.

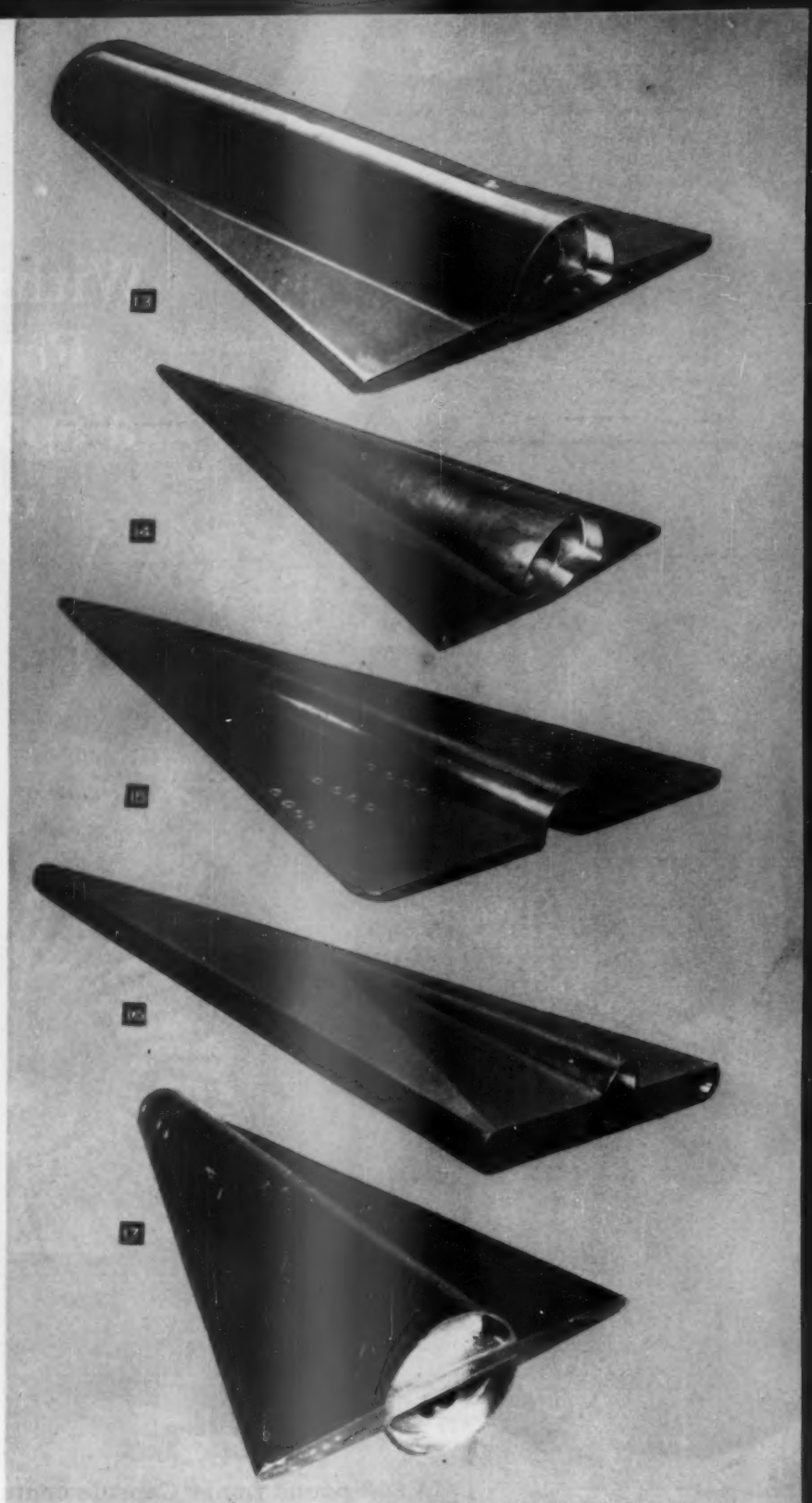
• **Optimum flight paths** for winged reentry vehicles which will minimize the aerodynamic heating problem are being investigated by the Convair San Diego Division. In this purely theoretical study, the calculus of variations is being used to calculate the angle of attack schedule to be followed by many types of winged vehicles re-entering along many different trajectories. These calculations are being made on an IBM 704 computer.

• **Study of the similarity** parameters pertinent to hypersonic flow is being made by Flight Sciences Laboratory of Buffalo, N. Y. Reynolds number, Froude number, Mach number and the other fluid flow similarity parameters which have made it possible in the past for small scale model tests to be used in the design of large vehicles are not adequate for hypersonic speeds. The high temperatures of hypersonic flight cause physical and chemical changes in the air. An accurate mathematical description of hypersonic flow is much more involved than a description of supersonic flow.

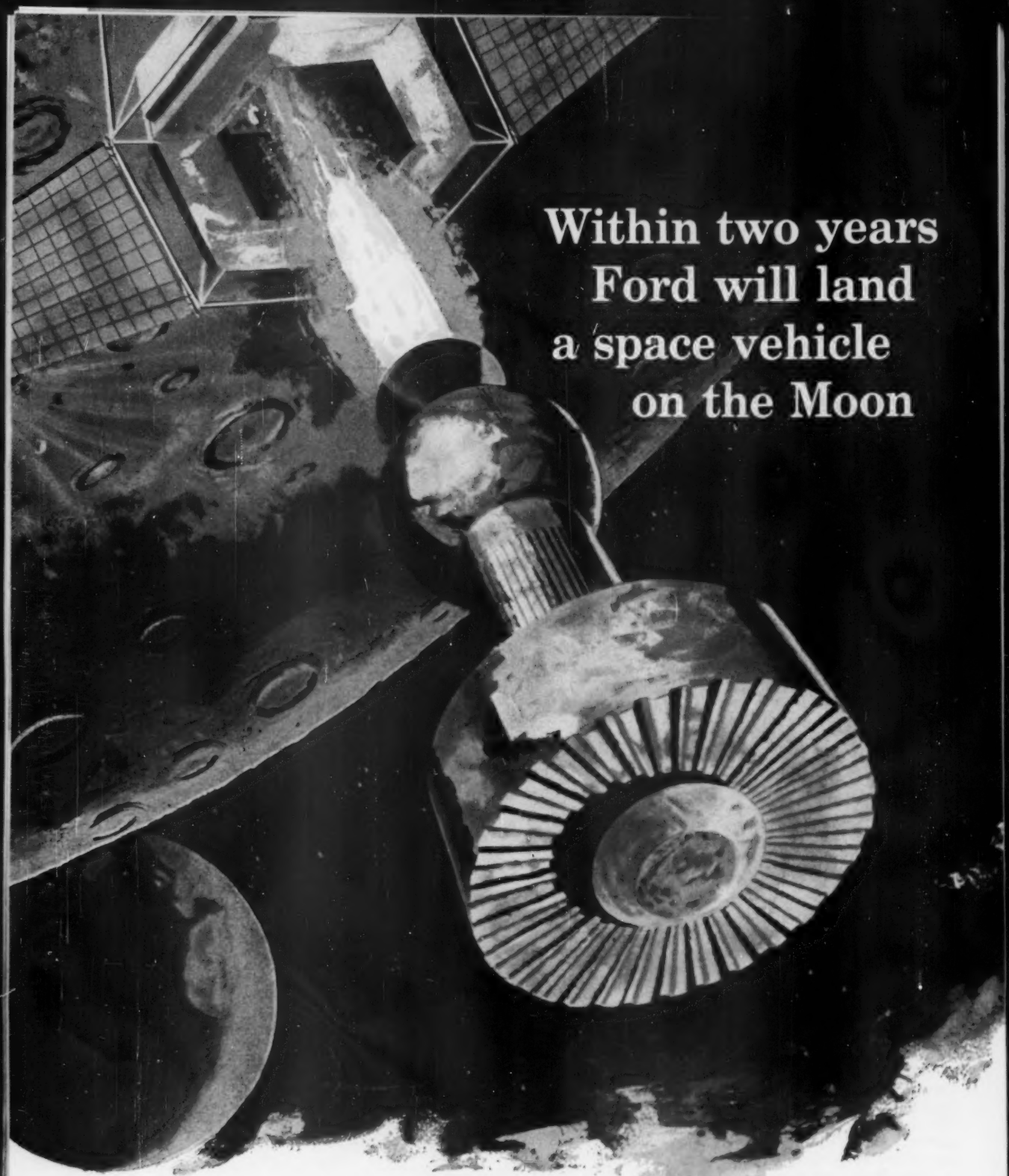
• **Six-degree-of-freedom flight** path analysis for hypersonic vehicles is being conducted by McDonnell Aircraft Corp. making maximum utilization of the capacity of an IBM 7090 digital computer. This program is set up so that a wide variety of problems may be solved quickly, from those involving point mass objects with two degrees of freedom to the most complicated six-degree-of-freedom studies of winged vehicles in which autopilot responses and rotating machinery effects are taken into consideration. Results of this work will be published in a WADD report which will describe quick computation methods for vehicle performance along any trajectory with reasonable navigational accuracy and to make error and dispersion analyses about nominal flight paths.

• **Free flight model** test program is being managed by the Flight Branch at WADD. In this program, large scale models of winged hypersonic vehicles will be boosted to Mach 20 by Air Force TS-609A rockets, which will be similar to the NASA Scout vehicles. The first of these models will be ready within a year. They are now in the preliminary design phase. Two types of models will be used: aerodynamic models for external configuration studies and structures models which will carry full scale structural sections from hypersonic vehicles.

Flight Sciences Laboratory has the preliminary design contract for two aerodynamic models, and McDonnell has a similar contract for three structures models. In general, the models will test



HYPERSONIC GLIDERS which have lightly loaded, insulating skin to protect the load-bearing internal structure from high temperatures will require a sizable internal volume for best structural efficiency. Models above will aid in determining the best means of providing this volume on a highly swept triangular wing. Model No. 13 has a modified cylindrical fuselage. Conical fuselages with less volume and drag are used on Models No. 14 and 15. Model 16 has a built-up flat-sided fuselage, and the fuselage on Model No. 17 extends below the wing. Various degrees of leading edge bluntness also are studied.



A 300-pound Lunar Capsule containing scientific instruments will soon make a "rough" landing on the Moon. It will be carried by a larger spacecraft to a location about 25 miles from the Moon's surface, then released. A retro-rocket will cushion its impact. The Lunar Capsule will transmit vital scientific data back to Earth for a month or more. This unique space vehicle will be the product of Ford Motor Company's Aeronutronic Division.

THIS LUNAR CAPSULE, now under development for NASA's Jet Propulsion Laboratory, is one of many space-oriented programs now under way at Aeronutronic Division of Ford Motor Company.

These programs—and many others related to advanced weapon systems and computer systems—are being carried out at Aeronutronic's multi-million dollar Engineering and Research Center, in Newport Beach, California. They emphasize Ford's rapidly growing role in meeting the needs of science and defense in the Space Age.

A booklet describing Aeronutronic's accomplishments and capabilities is available to you on request.

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concepts being used on the Boeing Dyna-Soar, and they will provide the first large scale hypersonic flight data. If the model flights are successful and their instrumentation and telemetry systems function properly, they will produce the best data available for the design of hypersonic vehicles.

It is possible that this large scale information will solve the problem of finding the correct similarity parameters for use in hypersonic flow. If this can be done at an early date, then the uncertainty surrounding many of the very small scale hypersonic tunnel tests could be lifted. A large number of these tests have been made to date, but many questions still surround the interpretation of the data, and it is not clear exactly how it should be applied to the design of full-scale vehicles.

Models which will be boosted to near-orbital speed by the TS-609A rockets are called aerothermodynamic models by the Air Force, and it is probable that they will fail and disintegrate somewhere near the end of their flight trajectories.

Internal applied research programs at WADD include aerodynamic heating investigations on highly swept wings at large angles of attack ranging from minus 90 deg. to plus 90 deg. Studies are being initiated on wingless lifting bodies for hypersonic vehicles.

Detailed studies are also sponsored on the low-speed flight characteristics of hypersonic vehicles, possible uses of magnetohydrodynamic cooling systems at very high speeds, efficient air inlets for hypersonic speeds and every other design area pertinent to very high speed vehicles.

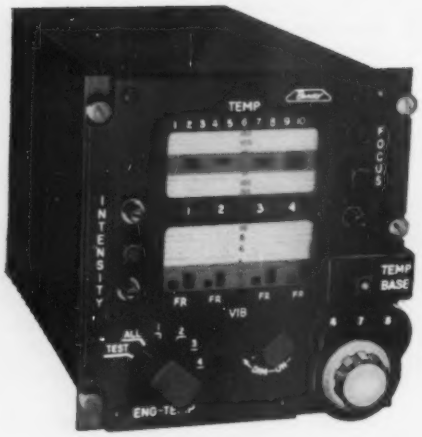
Solar Power Unit To Generate 100 w.

Washington—Prototype satellite solar power unit designed to generate 100 w. is being built by Hamilton Standard Division of United Aircraft for Wright Air Development Division and is expected to be ready for ground test this fall.

Folding generator will mount approximately 900 aluminum reflectors 4 in. in dia. over a 100 sq. ft. area. Reflectors, assembled in groups of 28 on aluminum tubing, will focus solar light on radiation collectors in their centers. The sun's heat is conducted to one end of a thermocouple, whose temperature may rise to 1,000F, while the temperature at opposite end, which is cooled by radiation from the reflector's back surface, may be reduced to 400F. Temperature differential causes a voltage flow.

Solar generator capability eventually will be increased to an output of 1,500 w.

ANNOUNCING A NEW DEVELOPMENT BY BENDIX



TEMPERATURE VIBRATION MONITOR*

FOR TURBINE ENGINES

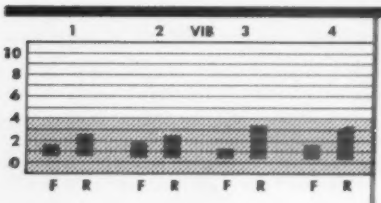
Provides a continuous condensed display of turbine engine vibration and temperature conditions

A landmark in engine instrumentation progress is the Bendix* Temperature-Vibration Monitor which simultaneously displays the findings of 40 temperature and 8 vibration sensors strategically located on all 4 engines of a turbine powered aircraft. This data is presented on the flight deck of the aircraft in bar graph form so that it can be continuously monitored and easily read.

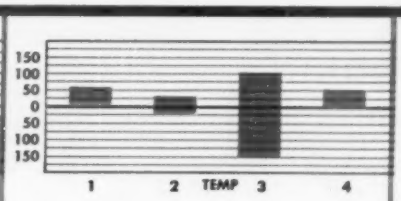
The average displacement of 8 vibration pickups is displayed continuously on the lower cathode ray tube with the top of the bar graph indicating vibration displacement on the grid scale. This continuous monitoring of vibration immediately indicates excessive unbalance on the jet engine.

The temperature analysis normally associated with the exhaust gas thermocouples will locate faulty burners, bad combustion distribution and plugged nozzles or any unusual hot or cold conditions around the turbine engine exhaust. The temperature display in the "all" position presents maximum and minimum temperatures on the upper cathode ray tube continuously for the four engines as reference to a temperature datum set in by the operator. The individual engine temperatures can be displayed as 10 bar graphs whose deflection can be read on the tube scale as deflections above or below the temperature datum, and individual degrees may be accurately and easily read from the digital read-out dial.

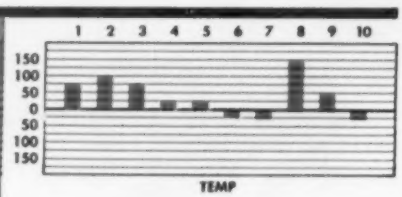
The equipment, initially developed for BOAC, is applicable to all airline and military turbine powered aircraft. The equipment for the four engine installation is approximately 30 lbs. and includes the Temperature-Vibration Monitor pictured above and a remotely mounted ½ ATR short box. *TRADEMARK



Vibration indication for four engines with front and rear pickups on each. Height of display indicates total vibration displacement.



Temperature "all" display indicating maximum and minimum temperatures above and below temperature datum for four engines.



Temperature for single engine indicates all thermocouples indicating temperature above or below temperature datum reference.

Scintilla Division
SIDNEY, NEW YORK

Bendix
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Load Cell to Be Used in F-1 Rocket Testing

Type C-1C load cell built by Baldwin-Lima-Hamilton Corp. will be used to calibrate a functional load cell which will determine weight and thrust factors of the Rocketdyne F-1 rocket engine. Picture shows engineers at National Bureau of Standards, Washington, D. C., adjusting five 300,000-lb.-capacity proving rings acting in parallel used to calibrate the Type C-1C cell. Cell, a compression unit, weighs about 1,500 lb., is 20 in. dia.

PRODUCTION BRIEFING

Lovelace Foundation for Medical Education and Research has a $150,000 Atomic Energy Commission contract to explore the possibility of establishing an AEC biological research laboratory in Albuquerque, N. M.

Vitro Laboratories Division of Vitro Corp. will continue to operate and maintain Eglin Gulf Test Range instrumentation under negotiated $7 million USAF contract.

Rocketdyne Division of North American Aviation has signed a reciprocal technical and commercial agreement with Societe d'Etude de la Propulsion par Reaction, Paris, France, for promotion and sale of small liquid propellant rocket engines. The 10-year agreement provides the French company promotion rights for certain Rocketdyne-designed engines in continental Europe, Turkey and Iran. Rocketdyne holds similar U.S. rights for SEPR engines.

U. S. Air Force has ordered 35 Cessna U-3B twin engine utility aircraft (military version of the Cessna 310) which will be fitted with de-icing and anti-icing equipment for all weather operation. Deliveries will start in December.

Aerojet-General Aerobee-150A sounding rockets fired from National Aeronautics and Space Administration's Wallops Station are boosting 160 lb. payloads to altitudes of 150 mi. for stellar and solar observations.

Westinghouse Electric Corp. is building an air-portable nuclear powerplant being developed by Martin Co.

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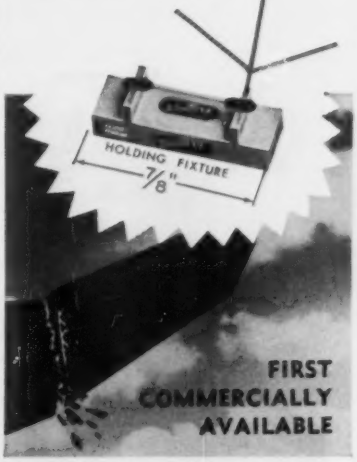

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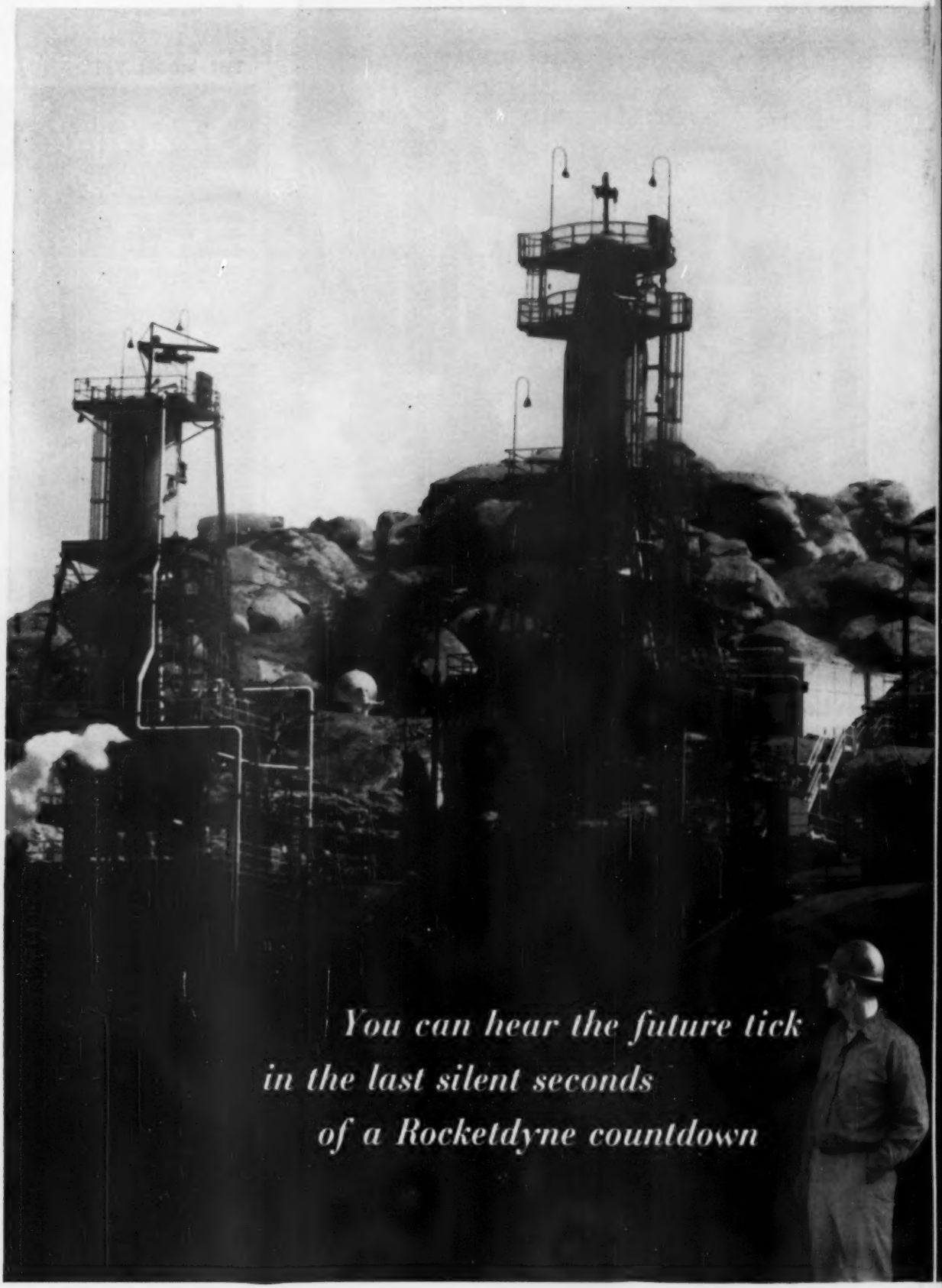
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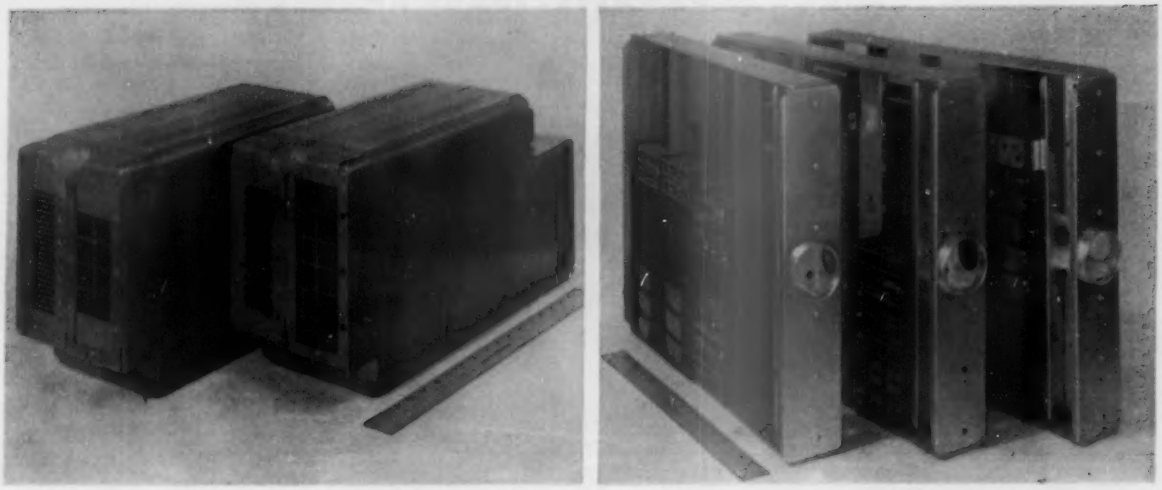

AIRBORNE VOCODER, developed by Hughes Aircraft for use on the B-70 and F-108, permits 6:1 reduction in bandwidth or automatic encrypting of voice communications with no increase in bandwidth (left). Ground-based vocoder (right) for point-to-point communications, provides duplex operation, weighs 200 lb. Vocoder decomposes speech into basic elements which can be transmitted in digital form, then used by vocoder at receiver to recreate original speech.

Vocoder Increases Channels, Security

By Philip J. Klass

Washington—Small, lightweight airborne vocoder (voice-encoder), which slashes the amount of radio spectrum required for voice communications and permits automatic encrypting for military security, was described here during the recent Military Electronics Convention.

Vocoder techniques are likely to find use in manned deep space probes and lunar exploration because the reduced bandwidth cuts transmitter power requirements.

New vocoder was developed by Hughes Aircraft Co., under Wright Air Development Division sponsorship, for the North American B-70 and F-108, under a program known as Project Quicksilver. The object was to provide dependable, secure long-range air-ground communications. Strategic Air Command plans to evaluate the Hughes vocoder for possible use on existing bombers to increase security of voice communications.

Airborne Vocoder

The new Hughes airborne vocoder, which can encode voice in either analog or digital format, weighs only 60 lb., occupies 1.3 cu. ft., and consumes less than 100 watts, Hughes' A. J. Strassman reported here. (The report was co-authored by K. C. Stockhoff.) The unit is designed for simplex operation. A duplex model vocoder, designed for ground-based point-to-point use, weighs 200 lb. and includes circuits both for compressing and digitizing speech for transmission as well as converting digital information back into synthetic speech.

In vocoder articulation tests conducted by Hughes, up to 90% of the individual words were intelligible, which should provide an over-all sentence intelligibility of about 99%, Strassman said. (Sentence intelligibility is higher than that of individual words because of inherent redundancy in sentence structure.)

Speech Compression

First vocoder was developed in the late thirties by Bell Telephone Laboratories as part of a program aimed at better understanding of speech and more efficient methods of transmission. In recent years, the military services have sponsored considerable research in the field of speech compression, aimed at reducing the bandwidth required for voice communications in order to squeeze more channels into the radio spectrum and/or to improve security (AW Aug. 17, 1953, p. 316).

Normally, a bandwidth of about 3,000 cps. is required for voice communications of good intelligibility. If encrypting is required, voice must be converted into digital format which increases required bandwidth to about 32,000 cps., according to Strassman.

The Hughes vocoder slashes the bandwidth required for voice communications to between 250 and 500 cps., permitting six or more times as many voice channels as conventional (uncompressed) voice communications. Encrypted vocoder voice can be transmitted with a bandwidth of only 3,000 cps., the same bandwidth needed for conventional unencrypted communications.

Basics of Speech

The human voice, Strassman said, consists of two basic types of sounds:

- **Voiced sounds, or vowels,** produced by vibration of the larynx under pressure of air from the lungs.
- **Unvoiced sounds, or consonants,** produced by movement or position of the lips, tongue and nasal passages.

The voiced sounds, or vowels, are the predominant carriers of information in human speech, while the unvoiced sounds give speech the characteristics which make it possible to distinguish one person's voice from another's.

The voiced sounds consist primarily of harmonics of the frequency at which the larynx vibrates, normally in the range of 70 to 250 cps. for men and as high as 350 cps. for women. The unvoiced sounds have no definite harmonic frequency pattern, being composed of frequencies randomly distributed throughout the spectrum and varying in amplitude according to the sound being produced, Strassman said. In most instances, voiced and unvoiced

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sounds do not occur simultaneously in human speech.

There are several different approaches to the design of a vocoder. The approach used by Hughes is called "fixed-channel analysis." By means of a series of 12 bandpass filters, voiced sounds are decomposed, or separated, into sound energy in 12 segments of the audio spectrum from 200 to 4,100 cps., after first having passed through a voice-operated gain adjustment device (VOGAD) in which speech volume is automatically adjusted to a uniform level.

The bandwidth of the individual filters varies from 160 cps. at the low end of the spectrum to 755 cps. at the high end.

The output from each bandpass filter passes to a corresponding spectrum analyzer which measures the power density of the sound in its assigned frequency range. The output from each spectrum analyzer is then fed to an electronic commutator, or time multiplexer, which examines the magnitude of each analyzer output in time sequence, once every 21 milliseconds.

The output of the multiplexer can then be transmitted as pulse amplitude modulated signal (PAM), or converted into binary form, as desired.

Receiving End

At the receiving end, the process is essentially reversed to synthesize sound that resembles human speech. There are the same number of spectrum analyzers and bandpass filters, each covering the same segments of the spectrum as in the transmitter vocoder. An audio energy source, referred to as the "buzz generator," provides the energy for voiced or vowel sounds, while another called the "hiss generator" supplies energy that produces the unvoiced, or consonant sounds.

The amplitude of signal received from the transmitter vocoder for each segment of the audio spectrum causes the appropriate synthesizer to produce a sound of comparable power intensity. The outputs from all 12 synthesizers, after passing through filters which remove unwanted harmonics, are then combined, amplified and fed to a loudspeaker.

At any instant when the speech is predominantly unvoiced (consonants), a circuit in the transmitter vocoder, called the "pitch extractor" is activated.

This transmits a signal to the receiving vocoder which causes it to momentarily disconnect its "buzz generator" and substitute a "hiss generator" which supplies the random frequencies contained in the unvoiced sounds.

At such times as the human speech contains both vowels and consonants simultaneously, the combination is treated as if only vowels were present and the hiss generator is not activated.

The output of the transmitter vocoder can take the form of pulse amplitude modulation in which the output of each of the 12 spectrum analyzers is defined by one of eight levels, while the pitch extractor signal is quantized into 64 amplitude levels.

Modulation Techniques

Normal voice can be digitized directly using pulse code modulation or delta modulation, but such techniques require 20,000 to 50,000 bits per second for adequate quality, Strassman said. This high bit rate is seldom economically justifiable for only one voice conversation.

With the vocoder, its output can be converted directly into a digital bit stream which requires only about 2,000 bits per second data rate. Furthermore, digital error rates as great as 1-2% have negligible effect upon speech intelligibility whereas they would cause up to 10% of the characters in an ordinary teletype system to be in error, according to Strassman.

Various types of phase modulation or frequency modulation can be used to transmit the digital bit stream. The use of vocoder and digital transmission techniques should improve the reliability of voice communications in the high frequency band in the face of both natural and man-made interference, Strassman indicated.

Strassman said that any desired level of secure transmission of speech signal can be achieved through use of digital bit stream transmission of voice.

System Savings

For point-to-point communications, a number of vocoder bit stream transmissions can be time-multiplexed with a significant saving in spectrum, facilities and cost, according to Strassman. Using the existing state-of-the-art, it is possible to transmit 32 fully encrypted speech channels, with a substantially higher average to peak power ratio, using facilities that now provide only 24 non-encrypted voice channels, and with much less complex multiplexing equipment, Strassman said.

Using a bit stream rate of 2,000 per second, the present vocoder design has achieved word articulation scores of 85 to 90%, giving near-perfect sentence intelligibility, according to Strassman.

The present Hughes airborne vocoder is fully transistorized, except for one subminiature thyratron used as a noise source. Airborne unit uses 250 silicon transistors and 915 diodes, which enable unit to operate up to 100C temperatures. Ground-based duplex vocoder uses 330 silicon transistors and 1,325 silicon diodes.

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HOT EMISSION tube is placed in output beam of monochrometer to measure photo emission traits. Work being done by Dr. W. E. Spicer (shown), RCA Laboratories, Princeton, on electron emission from semiconductor junctions is supported by Army Signal Corps.

Semiconductor Emission Studies Aim at Better Electron Tubes

By Barry Miller

Ft. Monmouth, N. J.—More efficient electron tubes are the goal of a series of research studies into electron emission from semiconductors being conducted here at the U. S. Army Signal Research and Development Laboratory and in a few other laboratories throughout the country.

Semiconductors may prove to be excellent electron sources for tubes once scientists gain a better understanding of electron emission from single-crystal and polycrystalline semiconductors and the mechanisms responsible for it. They could replace the conventionally heated cathode—long a mixed blessing. The heated cathode is the electron source which makes tube operation possible. It also has its wasteful side. Heating requires power which adds undesired weight in space and the heat generated must also be removed.

Heater Filaments

For this reason, and the desire to do away with the heater filaments, usually a first source of tube failure, scientists for some time pondered over and sought ways of improving electron tubes by using unheated, or "cold" cathodes, coated with materials like polycrystalline semiconductors.

Although the major portion of a current series of government-supported studies of electron emission at the Evens Area of the Signal Laboratory in nearby West Belmar and elsewhere are not now seeking new devices, but rather a fundamental understanding of emission phenomena, some practical achievements are a matter of record.

Cold Cathode

Eighteen months ago, this laboratory along with its contractor, Tung-Sol Electric Co. of Newark, demonstrated the results of several years' effort —the cold cathode tube (AW Feb. 2, 1959, p. 64). The cathode of this device is covered with a porous polycrystalline compound semiconductor—magnesium oxide—which emits electrons in sufficient quantity so that the tube can be operated without the customary tube warmup time and without the need for a filament and its supply. The tube thus avoids a frequent source of failure, requires less power than comparable thermionic devices and saves the space which normally would be occupied by the filament transformer.

Parallel to this work are several years of study, pioneered by Jack A. Burton and others at Bell Telephone Laboratories, into electron emission from the surface of back-biased semiconductor junctions. Such emission has been observed at several laboratories in a num-

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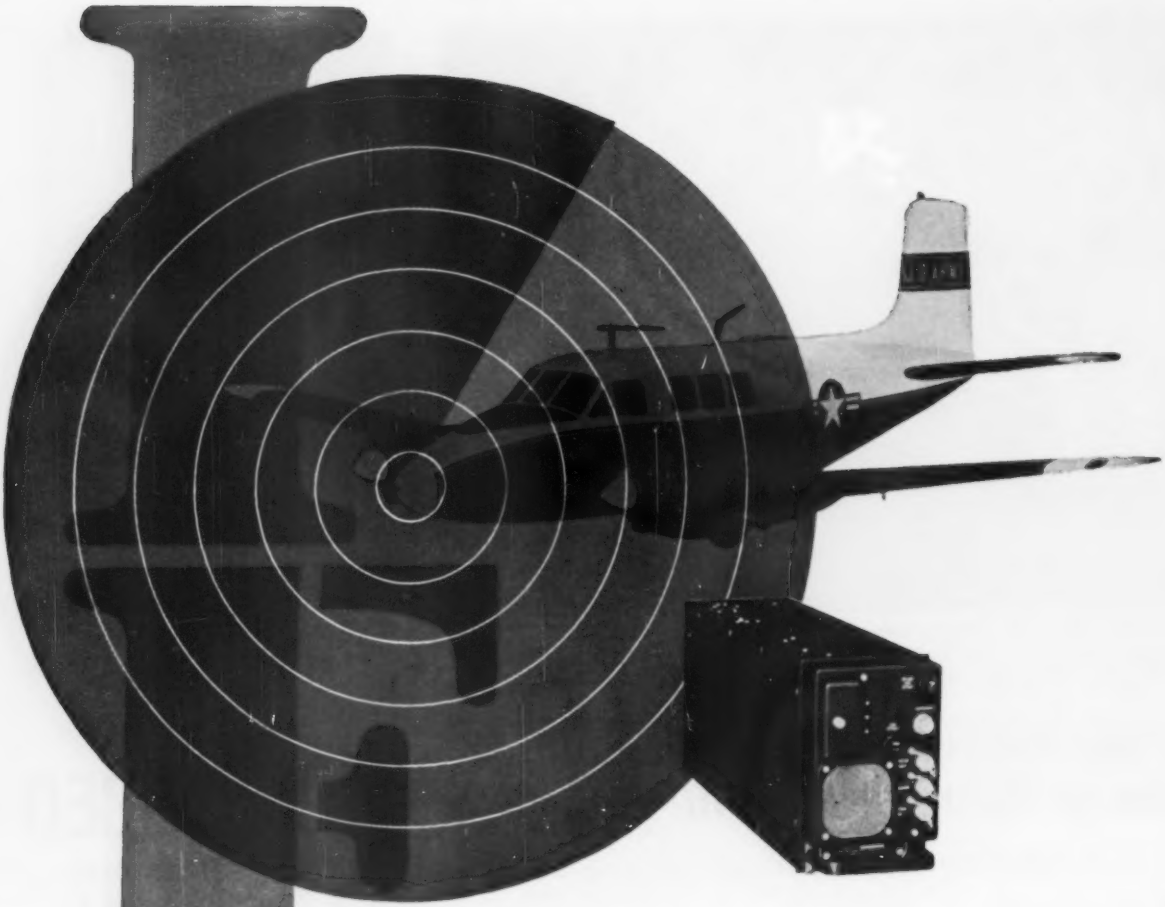

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ber of semiconductors—silicon, germanium, silicon carbide and diamond among others. These observations led to speculation about the feasibility and potential advantages of a hybrid electron tube, with the semiconductor junction emitter replacing the normal cathode, which might lie beyond this early, exploratory research.

Research Efforts

The Signal Corps, and to a lesser degree, the Navy Bureau of Ships are now supporting a number of complementary research efforts regarded as the first steps in this direction. The Army's effort, according to Dr. Dietrich Dobischek and Louis N. Heynick at Evans, is proceeding along two lines. These are:

- **Further study** of cold-cathode tubes and the phenomena, still not theoretically understood, behind electron emission from polycrystalline materials.
- **Study of electron emission** from single crystal pn junctions.

At present, the relation between the two emission phenomena is not known. Both involve some type of internal field emission, Heynick says. In the pn junction, an internal electric field imparts sufficient energy to electrons for them to escape over the surface barrier. Emission from magnesium oxide also involves a form of internal field emission and possibly, Heynick says, the same mechanism responsible for emission from pn junctions joins others in producing emission in the cold cathode.

In the area of electron emission from single crystal pn junctions, the Signal Corps is backing fundamental studies of what it calls "hot" electron emission under a two-year, $160,000 contract with RCA Laboratories in Princeton, N. J.

Hot electron emission refers to the heating of electrons alone and not the crystal lattice itself as is done in normal thermionic emission.

Density Increased

As part of this work, the company has reproduced and advanced earlier work with pn junction electron emission. RCA scientists increased the density of electron emission and the total current emitted from the junction by devising new techniques for coating the junction with cesium. The cesium coating lowers the work function which acts as a barrier, preventing electrons from escaping from the semiconductor.

Uncoated silicon junctions emit fractional microampere currents; earlier cesium coating boosted this by several orders of magnitude. Now milliampere currents are obtained on a pulse basis before the crystal lattice heats up and electron emission drops. These pulse experiments indicate, Heynick says, that a high order of magnitude emission

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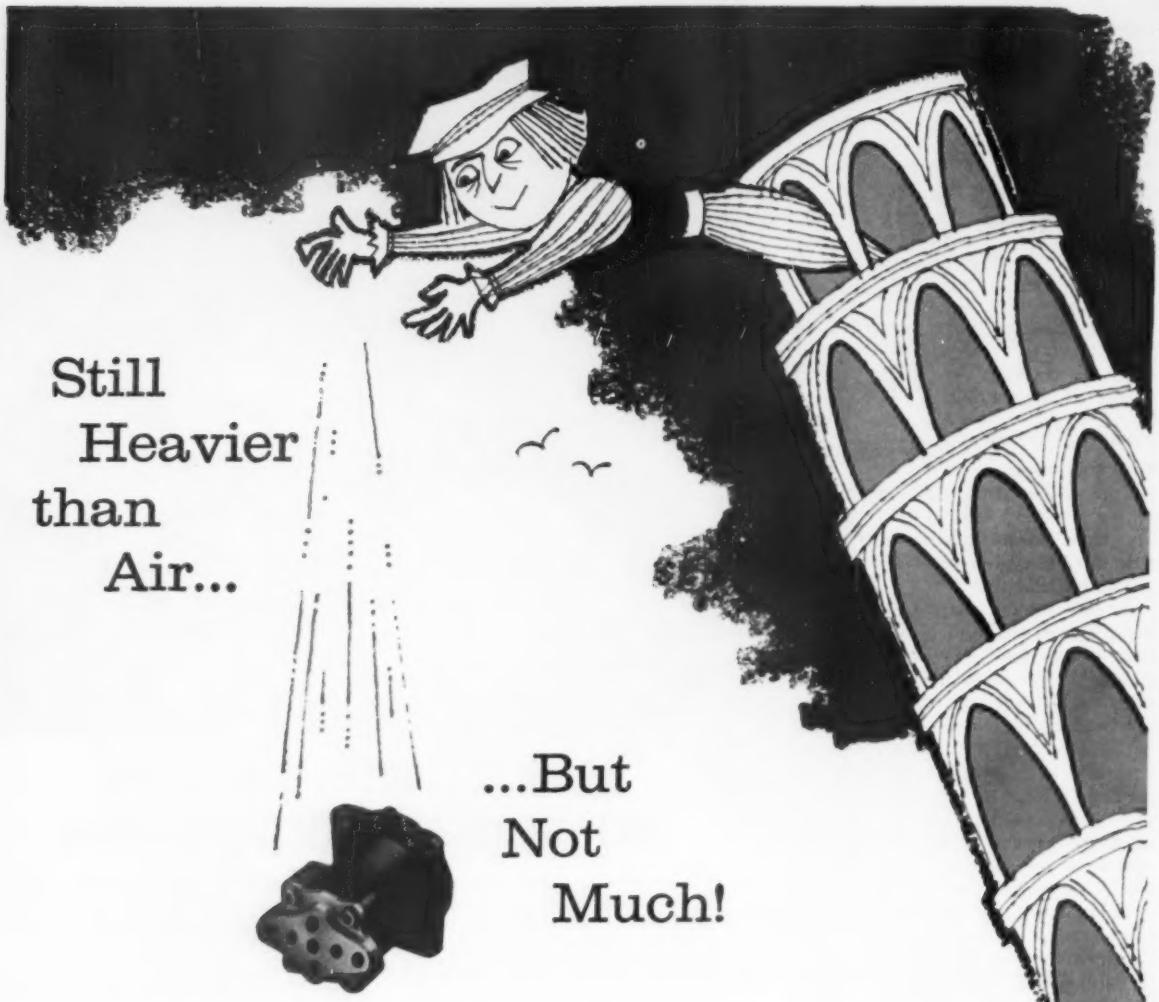

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from silicon and germanium junctions is possible.

RCA is trying to hammer out a complete theory to explain junction emission. One interesting byproduct of its work, according to Heynick, was a recent observation of field assisted photo emission. Light focused on a back-biased silicon or germanium pn junction produced electron emission over and above that expected from electron emission. Besides offering another tool for studying electron emission, this suggests the possibility of obtaining longer wavelength infrared photo detectors.

In addition to the work at RCA, Nuclear Corp. of America, Denville, N. J., recently began a search for a suitable group of semiconductors for junction emission under a $150,000 Navy Bureau of Ships contract. Nuclear is looking at large band gap semiconductors which have the theoretical advantages of reducing the effect of electron affinity—which might make the cesium treatment unnecessary—and a more stubborn resistance to heating.

Magnesium Oxide Types

Since the initial demonstration of cold cathode tubes, development has continued on the magnesium oxide type of tube and emission. Use of cold magnesium oxide cathodes in electron guns for cathode ray tubes has been demonstrated, according to Dobischek. The cold cathode has been used in combination with secondary emitters, like photomultipliers. One recurring and bothersome problem in cold cathode emission, however, is the falloff in electron emission due to heating after short operating periods. This could be overcome, Dobischek says, by proper physical design so that the cathode could be cooled to room temperature after emission heats it.

Rather respectable electron densities, in the neighborhood of 200 ma/cm², roughly comparable to thermionic emission, are being achieved in the laboratory here.

The cold cathode also tends to be noisy—presently an order of magnitude more so than a better quality thermionic cathode. This rules out its use in pre-amplifier stages although the noise is not so excessive that the tube cannot find duty as an output amplifier. More uniform cathode preparation does lower the undesired noise. But it is not now known whether noise effects are a fundamental limitation. For this reason the Signal Corps is anxious to learn what mechanism or mechanisms cause emission in an effort to know how they can be controlled.

Currently, out-of-house Signal Corps work which may lead to some of these answers comprises:

• **$100,000 one-year contract** with Tung-Sol which involves the study of

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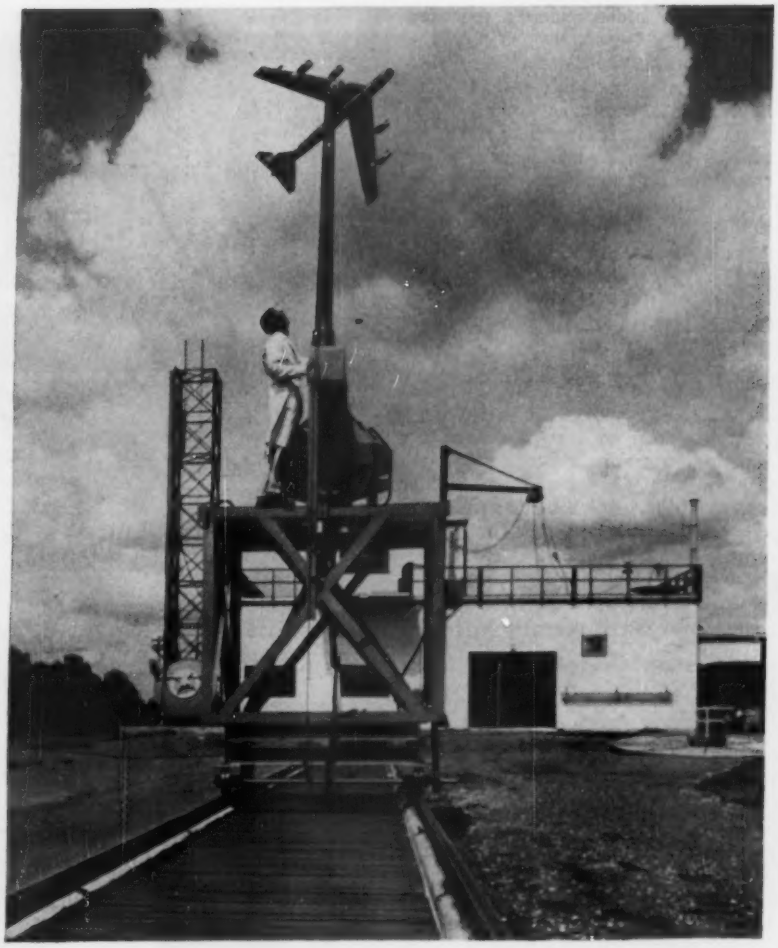


Boeing Studies Antenna Radiation

Scale model of a Boeing B-52G jet bomber is used in measurement of radiation patterns given off by the aircraft's antennas (AW Apr. 11, p. 101). Work is under way at Wichita, Kan., division; model can be rotated around two axes as signals are transmitted.

noise properties, impedance and other characteristics of cold cathode tubes as a function of different preparations of magnesium oxide and other compounds.

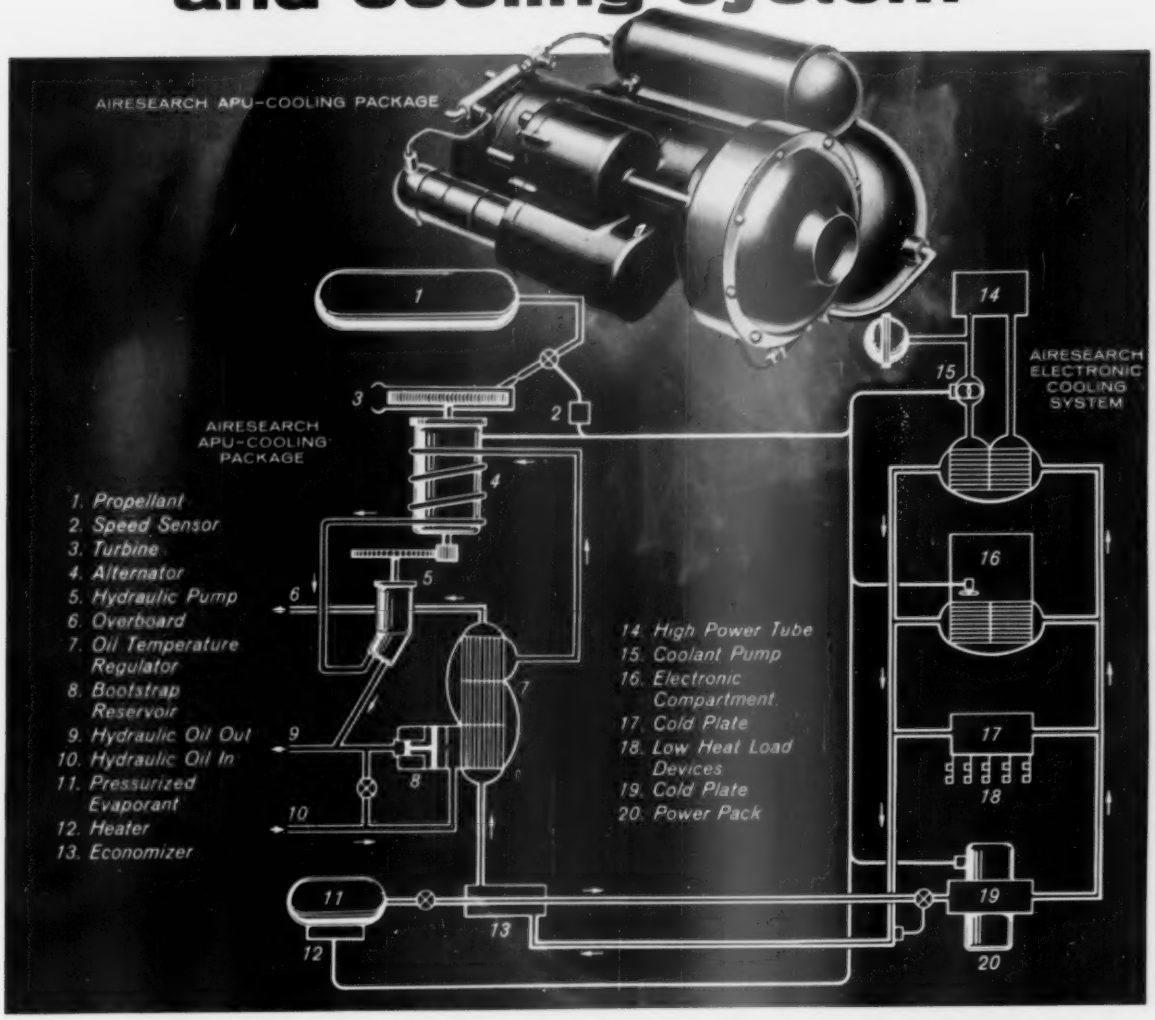
• **$75,000 two-year contract,** awarded in mid-June to Philco, for the task of piecing together a theoretical explanation of the mechanism involved in cold-cathode emission. Philco will conduct very little experimental work but is expected to design the experiments to determine the nature of the emission mechanism.

Total electron emission from magnesium oxide is well ahead of that from pn junctions. Emission densities from junctions appear to be on the rise although it is hard to isolate the emitting surface and therefore be sure of the density. Total emission, however, is still not in the class of the magnesium oxide type of emitter.

Besides this work in what might broadly be called internal field emission, the Signal Corps, the Navy and the Air Force are supporting work on external field emission conducted at Linfield Research Institute. According to Heynick, internal and external field emission may be related fundamentally. Emission densities obtained at Linfield with high external fields are appreciable, about 10^7 amp./cm.^{2} although total emission currents are not yet in the ampere region. Linfield will study multiple point emission under a two-year $235,000 Advanced Research Projects Agency contract awarded in mid-June by the Signal Corps. It will attempt to determine the feasibility of multiple point field emission cathodes (high-power cathodes). BuShips' support of Linfield work, to the extent of $75,000 annually, as well as Air Force support, are to be phased into the Signal Corps work shortly.

A number of other companies, including Westinghouse, are known to be studying electron emission from solids with a similar aim of eventually producing better electron tubes.

Integrated accessory power and cooling system



meets the most advanced missile and space vehicle requirements

AiResearch has developed a *single* system package for missiles and space vehicles to meet increasing accessory power and cooling load requirements in the face of decreasing size and weight allowances.

This integrated accessory power and cooling system supplies hydraulic power for actuating systems, 3200 or 400 cycle three-phase electric power for guidance and control, and at the same time provides cooling both for the APU and all electronic equipment operating in the missile or space vehicle.

The cooling system in the example shown here uses liquid ammonia as the expendable evaporant, and each heat load area has a separate temperature control valve. Alternator and controls, turbine assembly and APU liquid propellant fuel tank are patterned after operationally proven components.

World leader in the design and manufacture of cooling and accessory power systems, AiResearch has delivered more missile APUs than any other company, and is the leader in advanced electronic cooling systems for aircraft, missiles and spacecraft.

AiResearch design and manufacturing experience in these two fields includes: liquid and solid propellant APUs; hydraulic and hot gas actuators and control systems; 3200 and 400 cycle alternators; cold plates; expendable and closed cycle gas and liquid cooling systems; cryogenic cooling systems.

Please direct inquiries to Los Angeles.

THE GARRETT CORPORATION

AiResearch Manufacturing Divisions

Los Angeles 45, California • Phoenix, Arizona

Systems and Components for: AIRCRAFT, MISSILE, SPACECRAFT, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS

Total weight of new Kinetics 1200 V.A. inverter is only 18.4 lbs.

WEIGHT BY ELEMENTS

	Pounds
Magnetic	9.0
Semi-conductor	0.6
Capacitors	1.1
Filter	3.1
All other electronic	0.2
Operating Components	**14.0**
Case & base plate	1.7
Mounting hardware	2.7
Total	**18.4**
Dimensions	
Length	10"
Width, including base plate	7"
Height	4"

Important savings in weight and size have been achieved in a new static inverter designed and built by Kinetics Corporation. A typical inverter with a sine wave output of 1200 V.A., for example, weighs only 18.4 pounds and occupies only 220 cubic inches. Even more spectacular weight and size characteristics per K.V.A. can be achieved in units with greater output.

These inverters are ideal for aircraft and missile applications in the range from 15 V.A. to 15 K.V.A. per phase. Kinetics static inverters may be connected in wye, delta, or parallel. Each unit will carry its own share of the load in parallel operation. No complicated or expensive hookup problems are encountered.

The reliable Kinetics' design uses rugged silicon diode semi-conductor elements that are able to carry heavy current. There are no moving parts, no vacuum tubes, and no transistors in high current circuits. Efficiency exceeds 80% at full load, dropping to 70% at half load.

Close frequency control and accurate phase displacement is obtained with crystal-controlled digital countdown circuitry. The Kinetics' design offers low-loss regulation. A high degree of reliability is achieved by the use of extremely rugged components and the lack of complex circuitry. Write or phone for more information. Kinetics Corporation, Dept. K-29, 410 South Cedros Avenue, Solana Beach, Calif., SKyline 5-1181.

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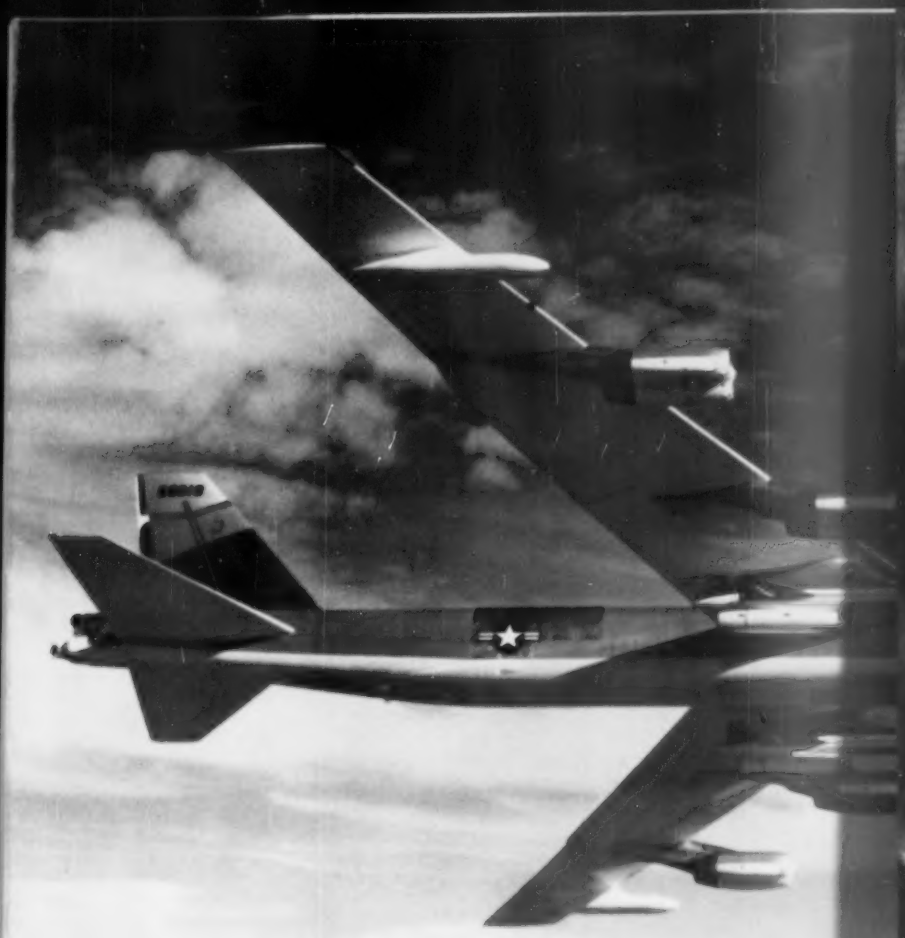

MOST ADVANCED OPERATIONAL ELECTRONIC WARFARE SYSTEM FOR OUR ARMED FORCES

The most potent airborne Countermeasures Equipments yet devised are being produced in quantity by Hallicrafters for our military aircraft. Teamwork with our armed forces continues to pay off for America – in more effective, more economical electronic warfare systems.

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Military Electron
Chicago 24,

"Big Stick" of the Strategic Air Command, Boeing B-52-G Missile Bomber can reach overseas targets and return without refueling.

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Please turn the page . . . for examples of Hallicrafters facilities, and Quick Reaction Capability in Airborne, Ground, Naval and Missile electronic systems for counter-measures . . . reconnaissance . . . maintenance and technical support . . . communications.

company

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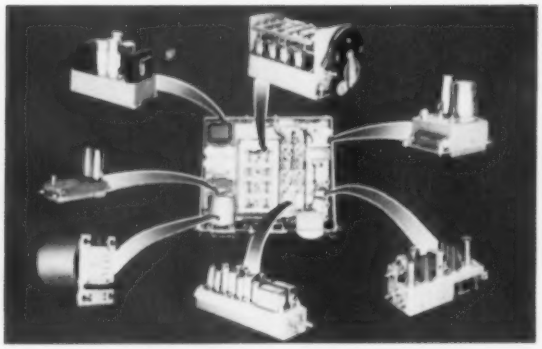
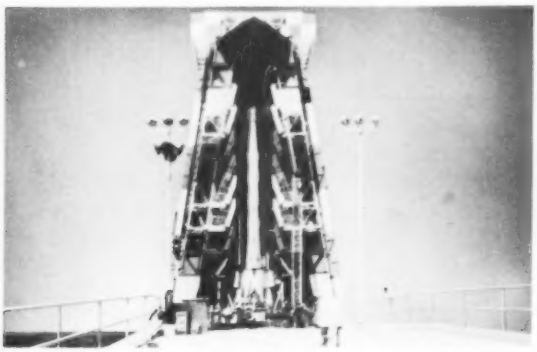
"There is but one lamp by which our steps are guided—the lamp of experience"
-Patrick Henry

For more than a quarter century, Hallicrafters has worked in close partnership with our armed forces on fast solutions to critical military electronics problems. Out of this priceless experience are emerging startling new ideas and hard-hitting, fast-moving techniques to keep our country one jump ahead in electronic warfare . . .

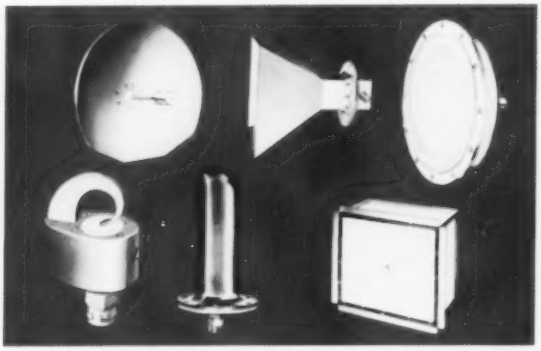
New levels of speed and efficiency are being reached in equipment modernization, retrofit and technical support programs with Hallicrafters' radical new "Blue Streak" project. Specially-trained Maintenance and Technical Support Teams, close-knit and flexible, can be tactically deployed to accomplish maintenance, installation and testing of electronics weapons systems anywhere in the world.



Hallicrafters communications leadership is exemplified by new high frequency Single Sideband receiver, (model no. S.W.E.) 100% modular design permits simple modification for compatability with existing and future communications systems. Stability, with proper available plug-ins, is better than one part in 10,000,000 per month. Hallicrafters also offers an existing capability in receiving and transmitting techniques up to frequencies of 50,000 megacycles.



Hallicrafters participation in the Atlas missile project helped to develop capability for many areas of the complex missile field, including code translator data systems; ground support equipment; ECM testing and antenna systems. Current explorations involve latest Infra Red techniques.



Airborne antennas and micro-wave components with power capability in excess of 1,000 watts, can be made available to solve tomorrow's very high power handling requirements. Testing of microwave components is possible with special high power generators, designed and built by Hallicrafters.

For further information on Hallicrafters facilities and experience in military electronics research, development and production, please write to:

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Military Electronics Division, 4401 W. 5th Ave., Chicago 24, Ill.

Looking for a challenging new opportunity? We are interested in qualified engineers at all levels. For full details in confidence, contact William F. Frankart, Director of Engineering.

FILTER CENTER

▶ **Transistor Manual Available**—The Arinc Research Corp. has compiled first complete listing of military and commercial transistor procurement specifications, published in loose-leaf binder. Transistor specification manual is offered at $6.50 if order is received by Aug. 15; thereafter price will be $10.00. Orders should be sent to Arinc Research Corp., 1700 "K" St. N.W., Washington, D. C.

▶ **Signed on the Dotted Line**—Major contract awards recently announced by avionics manufacturers include:

• **Computer Equipment Corp.,** Los Angeles 25, Calif., will deliver two radar quantizers for a Pershing missile altimeter ground station to the Diamond Ordnance Fuze Laboratories.

• **General Electric's** Heavy Military Electronics Department will produce AN/FPS-24 frequency diversity search radars under a $15,625,000 contract from Rome Air Materiel Area.

• **Melpar, Inc.,** will produce target detecting devices under a $1.4 million Bureau of Naval Weapons contract.

• **Federal Electric Corp.** has received a $40,763,711 follow-on contract from Rome Air Materiel Area for operation and maintenance of the Distant Early Warning (DEW) Line.

• **Sylvania Electric Products** will produce electronic countermeasures equipment for the B-58 Hustler with the receipt of a $20 million award from Convair, prime contractor on the Hustler.

• **Space Electronics Corp.,** Glendale, Calif., will fabricate programing and sequencing gear, autopilot control system, missile electrical system and such instrumentation as range safety and telemetry systems for the Able Star upper stage booster under a $1 million subcontract from Aerojet-General.

• **Summers Gyroscope Co.** will turn out free gyros for use in the Navy's Terrier and Tartar missiles on the basis of two follow-on orders totaling more than $4 million from Convair-Pomona Div.

• **Remington Rand Univac** will produce and test electronic ground guidance computers for the Titan ICBM under contracts exceeding $26 million from the Air Materiel Command's Ballistic Missile Center, Los Angeles.

• **Collins Radio** will supply and install 20 radar microwave systems and 100 radar microwave repeaters for the Federal Aviation Agency's long range radar program. The new order, for more than $5 million, brings to better than $19 million the total of similar equipment ordered by FAA.

• **Servomechanisms, Inc.,** Hawthorne, Calif., will continue to produce absolute and differential pressure transducers for the bombing and navigation system of the Boeing B-52. New orders for the transducers came from International Business Machines Corp. and total $508,855.

• **Hallamore Electronic Division** of Siegler Corp. is to fabricate and check special test equipment for the Titan ICBM under contracts totaling about $1 million from Martin's Denver Div.

• **Whittaker Gyro Division** of Telecomputing Corp., Van Nuys, Calif., will produce gyros for the guidance system of the Army's Nike Hercules missile under more than $588,000 in orders from Western Electric Co.

• **Bendix Radio** will build large electronically steerable array radar (ESAR), which will be used to track space vehicles launched from National Aeronautics and Space Administration's Wallops Island facility, and to monitor air traffic in the Baltimore-Washington area. Work is covered by a $4 million contract awarded by Rome Air Development Center and the Advanced Research Projects Agency.

• **Ryan Electronics Division,** Ryan Aeronautical Co., $34 million contract from Navy Bureau of Weapons for AN/APN-122 (V) doppler navigation systems, spares and support equipment.

• **Lear, Inc.,** Santa Monica, Calif., $8.2 million in letter contracts for gyro indicating systems from Air Materiel Command. Lear also reports contract, in undisclosed amount, for automatic tracking telemetry receiving systems from Lockheed Missile and Space Division. Equipment, to operate in the 5,000 mc. band, will incorporate parametric amplifiers and automatic seeking, lock-on and tracking capability.

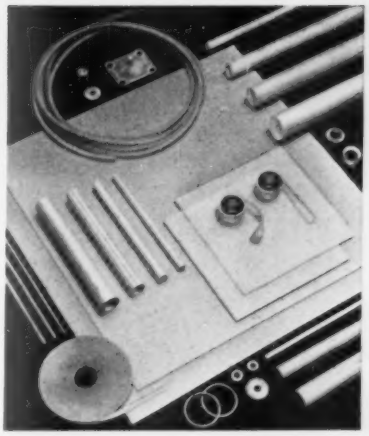
• **Bulova Laboratories, Inc.,** Woodside, N. Y., $244,000 contract for safe-arming device for missile warheads from Air Force Special Weapons Center.

• **Electronic Associates, Inc.,** Long Branch, N. J., $1.5 million contract for analog computer from National Aeronautics and Space Administration. Computer, to be installed at NASA's Langley Field center, will be largest in the world, company says.

NEW AVIONIC PRODUCTS

Components & Devices

• **Displacement gyro,** gas-driven device suitable for short range missiles, drones and target vehicles has only four moving parts. Gyro is designed for 2 to 4 deg./min. drift rate under extreme missile environments, has total of 40 parts, and meets performance requirements after exposure to 100g shock, 9g vibration and 30g acceleration and temperatures between 165 and



Now you can do even more with TEFLON

—made bondable by R/M

Time was, you'd often rule out "Teflon"* where it was sorely needed, simply because you couldn't make anything adhere to it.

But not now. R/M has perfected a process that makes "Teflon" easily bondable to other materials and to itself with commercial adhesives. Now you don't have to design intricate "Teflon" parts in a single piece or devise elaborate and costly fastening methods.

R/M can supply "Teflon" sheets and tape with bondable surfaces where you specify them. Thus you can use the remarkable electrical and chemical properties of "Teflon" without worrying about how to make it stay put. In fact, you can take advantage of bondability and non-bondability in the same R/M "Teflon" part.

A lot is happening in "Teflon" daily. To keep up with it, talk "Teflon" with the R/M man—learn of R/M's *complete "Teflon" service* that can help you improve design and increase reliability even while cutting costs. Call one of the offices listed below or write Plastic Products Division, Raybestos-Manhattan, Inc., Manheim, Pa.

*Du Pont trademark for its TFE-fluorocarbon resin

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CASE HISTORIES

N/D integral rolleron gyro wheel and shaft with precision instrument ball bearing solves sidewinder reliability problem. Actual ball bearing O.D. measures little more than an inch.

Designs Reliability Into Sidewinder Rollerons!

CUSTOMER PROBLEM:
With ever-increasing speeds of new fighter aircraft, the rollerons of this aircraft-fired missile failed because they were subjected to environmental conditions more severe than those for which originally designed.

SOLUTION:
New Departure engineers in conjunction with Naval Ordnance Test Station solved the problem by recommending a simplification of the original rolleron assembly. An integral gyro wheel and shaft was designed that maintains critical rolleron reliability. What's more, the new design reduces inventories, assembly time and inspections. And today, this same N/D creative engineering and reliability can be found in more than twenty of America's major missiles . . . in airframe, guidance, propulsion and ground support.

If *your* product has unusual ball bearing demands, call in a New Departure Sales Engineer. He's armed with a complete line of Miniature, Instrument and standard ball bearings . . . one that's sure to do the job for you! Write Dept. L.S., New Departure Division, General Motors Corporation, Bristol, Conn.

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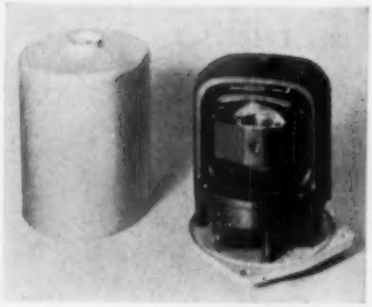
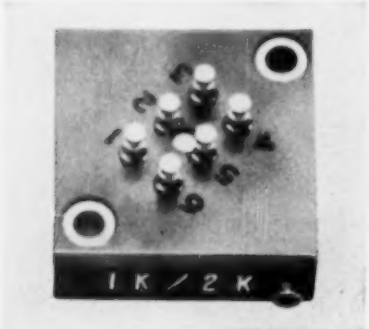
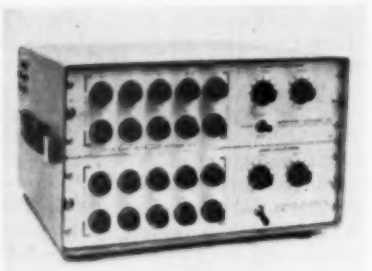
proved reliability you can build around



—65F. Average angular momentum of 1.25 million gm.-cm.²/sec. provides several minutes of stabilization. Lear, Inc., P.O. Box 688, Grand Rapids, Mich.



• **Trimming potentiometers,** 309 series, have two independent elements internally ganged into single ¾ sq. in. package allowing simultaneous adjustment of two circuits. 50 to 50,000 ohms are obtained from standard units and pots up to 65,000 ohms are available on special order. Heat dissipating aluminum case permits high power dissipation over wide temperature range. Daystrom, Inc., Pacific Div., 9320 Lincoln Blvd., Los Angeles 45, Calif.



• **Switch and Balance Unit,** Model C10 for use with strain gages and resistance bridge transducers features modular construction which permits assembly of systems ranging in size from 10 to 100 channels by connecting required units with plug-in cables. Completely automatic scanning and recording systems can be synthesized from these units when they are used with firm's resistance bridge potentiometer and output printer, according to the manufacturer, Automation Industries, Inc., 3613 Aviation Blvd., Manhattan Beach, Calif.

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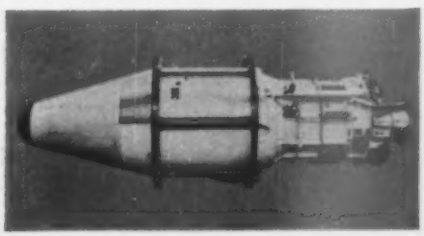

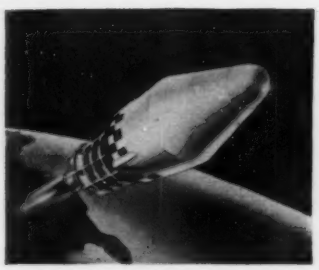

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telemetry components

Telemetry components designed and precision built by Dorsett Electronics will be aboard specially instrumented Lockheed Agena Space Vehicles to be flown in the Discoverer Satellite Program.

Lockheed Missile and Space Division is the latest in a long list of missile and satellite prime contractors to buy Dorsett telemetering components for advanced aerospace research programs.

Typical of the telemetering equipment originating at Dorsett Electronics is the Model 0-8 subcarrier oscillator. Requiring only 6 volts at .7 (nominal) milliamperes primary power, this all-silicon transistor unit provides excellent temperature stability for drift-free data. With its compact packaging, the Model 0-8 is ideal when electrical power is limited, space and weight are critical, and environmental extremes are to be encountered.

For more information on the products and capabilities of this fast growing team of telemetering specialists or on technical career opportunities, write today!

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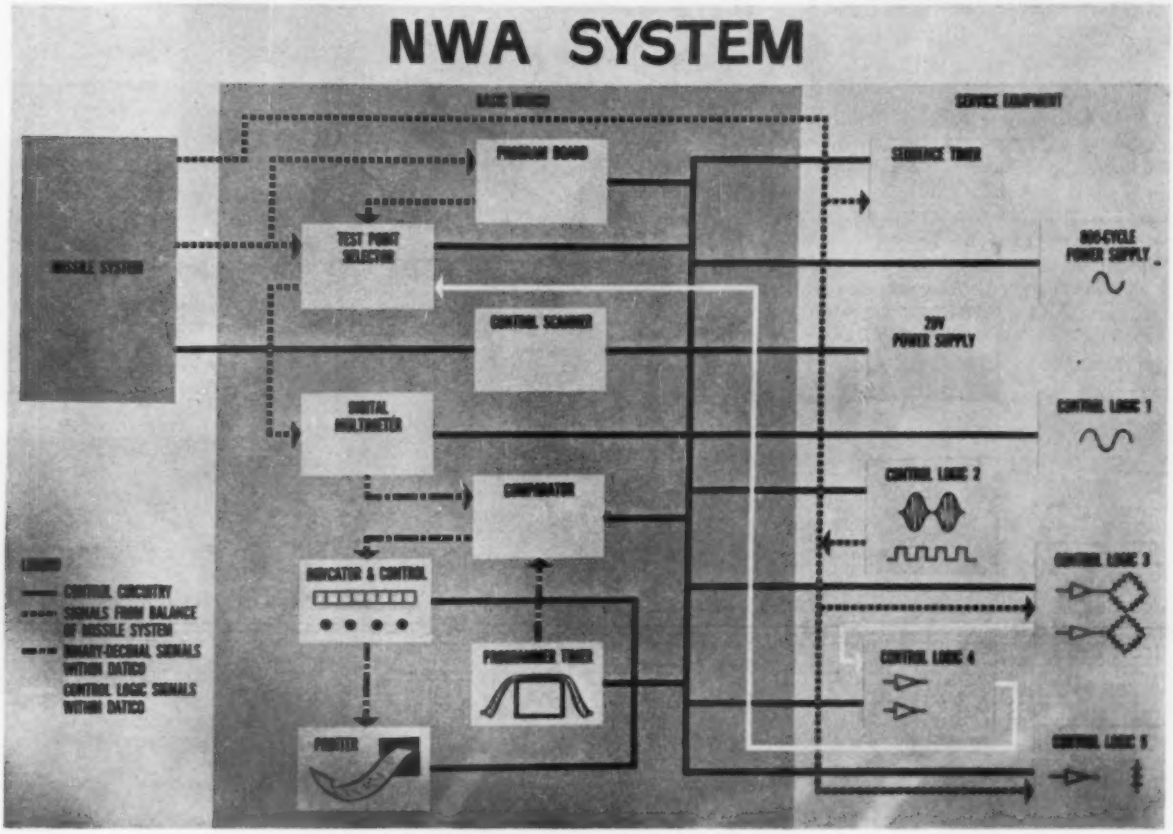


DATICO equipment similar to that used in missile-carrying submarines and their AS-19 tenders will be installed at the Naval Weapons Annex, Charleston, S. C. The equipment is nearly identical except for addition of power supplies and a sequence timer.

New Polaris Checkout Devices Developed

By Russell Hawkes

Anaheim, Calif.—Datico automatic checkout equipment for Navy's Polaris fleet ballistic missile, source of almost $15 million of business for Nortronics Division of Northrop Corp., grew out of a basic unit designed for no particular application and was developed with $70,000 of company money.

Lacking all of the specialized test components which must be associated with a specific application, Datico (digital automatic tape intelligence checkout) was intended by Nortronics to be tailored to a variety of systems by the addition of proper signal sources, measuring devices and displays. The engineering needed to adapt the basic Datico to a system to be tested is much less than that needed to develop a completely new set specially for the system to be tested, according to Nortronics officials.

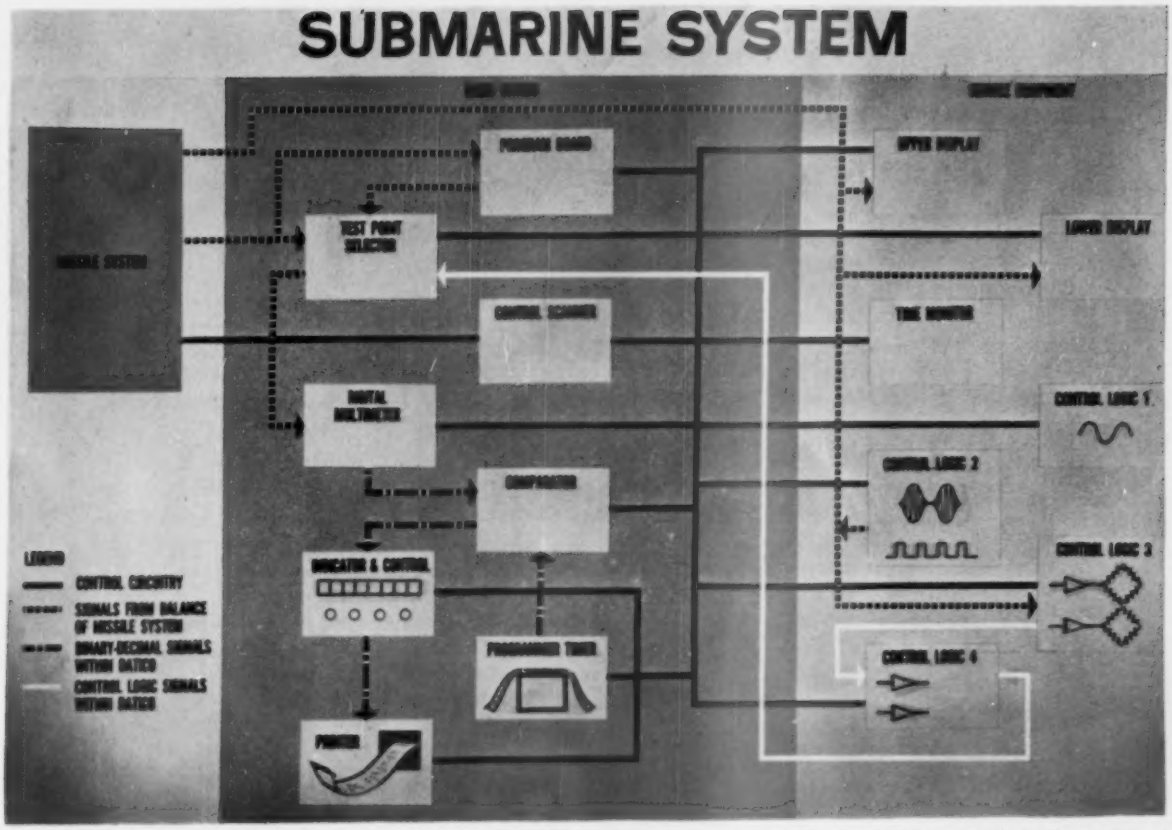
This advantage paid off in February 1959 when Navy Special Projects Office decided it needed a new Polaris checkout system quickly. After studying Datico for two weeks to determine whether it was suitable for the job, Navy let a contract to Nortronics to deliver a test unit built to commercial standards five months later on Aug. 1. Since then Nortronics has received orders for militarized versions to be installed on all George Washington-class submarines, their AS-19 Proteus-class tenders and at the Naval Weapons Annex, Charleston, S. C.

Tight Schedules

Dr. William F. Ballhaus, Nortronics general manager, attributes the success of the company in winning the Polaris-Datico contract largely to the ability to meet tight Polaris program schedules because of the building block development technique. Ballhaus says the rapid advance of technology in the field of checkout equipment has tempted most companies to incorporate each new discovery in their equipment while sacrificing any possibility of early delivery. Because of this, missile systems are usually in the field ahead of their checkout equipment. Often, he reports, the performance margin sought cannot be used by the system for which the equipment is designed.

In the second generation of Polaris-carrying submarines, Datico elements will be incorporated as part of an improved system called TRACE. Nortronics is conducting development work for TRACE under contract to Lockheed Missile and Space Division, system integration and airframe contractor for Polaris.

The design philosophy behind Polaris-Datico is to assure the readiness of the missile with a minimum amount of testing. This approach improves reliability of both the missile and the checkout equipment by simplifying circuitry and cutting down operating time on components. Datico installation aboard submarines is limited to determining whether or not the missile can be launched safely and reach the target. Therefore, the emphasis is on the functional testing of complete subsystems



BOX DIAGRAM for submarine-installed Polaris Datico shows the versatile programmer-controller in shaded area headed "Basic Datico." Nortronics adds a variety of service equipment to adapt the basic programmer-controller to a particular missile, airplane or electronic system.

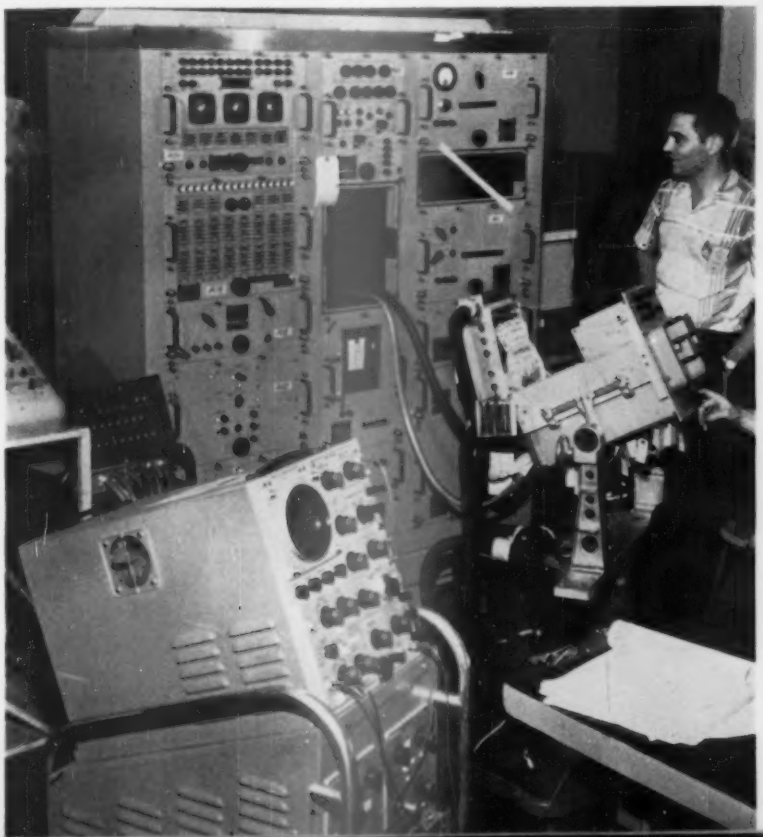
rather than on detailed trouble-shooting.

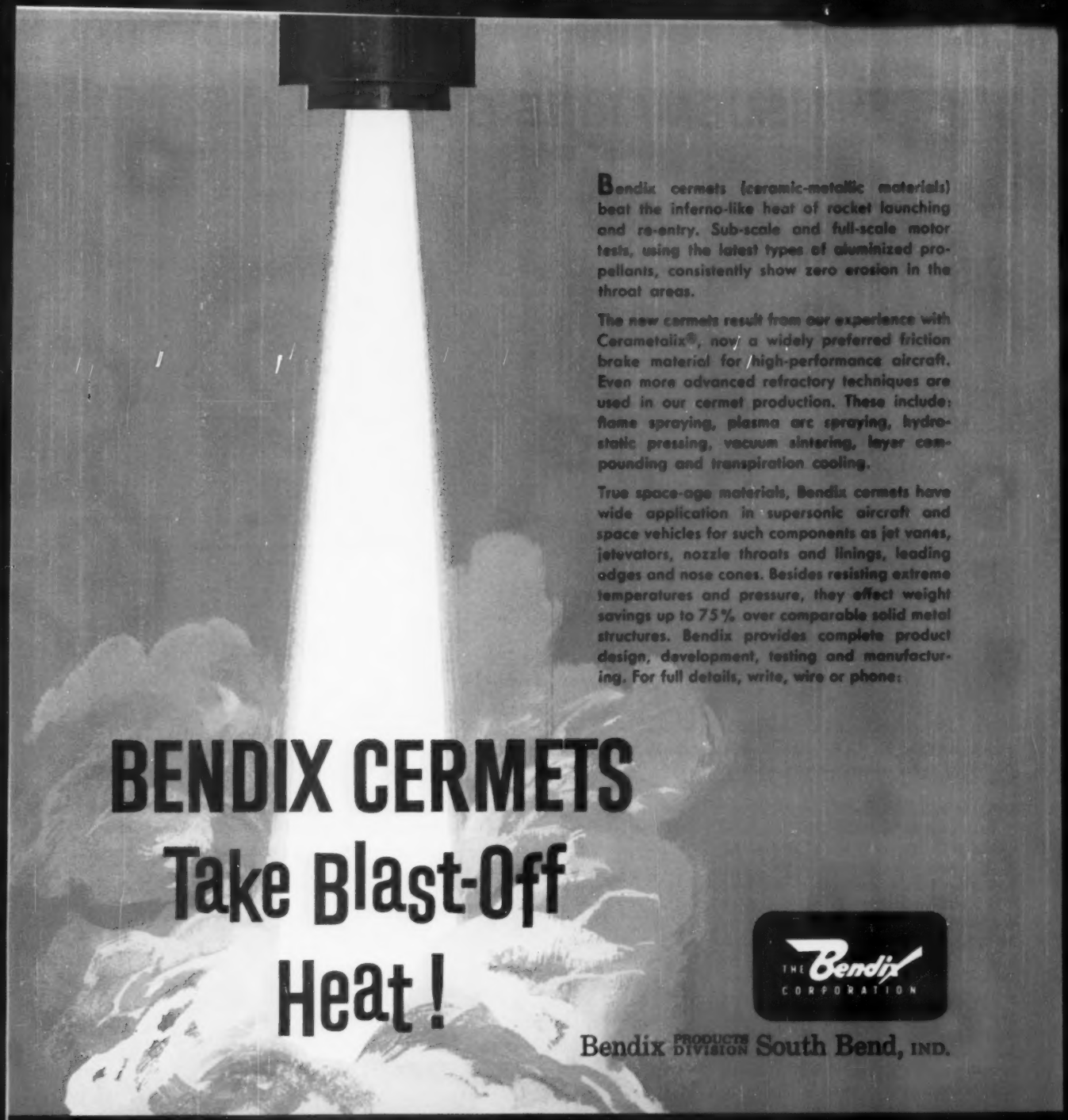
The value of knowing exactly which component has failed would be limited in the submarine environment since the opportunities for repair work are limited. Only one small crawl hole gives access to the base of the missile in its launcher.

The one major subsystem which can be replaced at sea as a standard practice is the guidance capsule, including the stable platform and the guidance computer. A complete supply of spare capsules will be carried aboard to replace installed ones which malfunction. These will be kept in a controlled environment, continuously monitored by Datico, and maintained in storage just like those in the tubes to ensure a quick change if needed.

Nortronics officials point out that in war there is usually more extemporized maintenance than is foreseen in peacetime. Some room for this is allowed in the Polaris checkout and maintenance plan, though it would be contrary to standard procedures. If there is time and need to replace or repair parts other than the guidance capsule, it is possible to reach and check some components with test scopes and other standard trouble-shooting sets. Ordinarily, if a subsystem other than the guidance capsule is found to be seriously out of

NORTRONICS Datico Mk. III missile test and readiness equipment is tested at Anaheim, Calif. plant before purchase by Navy. Special acceptance tester simulates missile circuits.





Bendix cermets (ceramic-metallic materials) beat the inferno-like heat of rocket launching and re-entry. Sub-scale and full-scale motor tests, using the latest types of aluminized propellants, consistently show zero erosion in the throat areas.

The new cermets result from our experience with Cermetalix®, now a widely preferred friction brake material for high-performance aircraft. Even more advanced refractory techniques are used in our cermet production. These include: flame spraying, plasma arc spraying, hydrostatic pressing, vacuum sintering, layer compounding and transpiration cooling.

True space-age materials, Bendix cermets have wide application in supersonic aircraft and space vehicles for such components as jet vanes, jetevators, nozzle throats and linings, leading edges and nose cones. Besides resisting extreme temperatures and pressure, they effect weight savings up to 75% over comparable solid metal structures. Bendix provides complete product design, development, testing and manufacturing. For full details, write, wire or phone:

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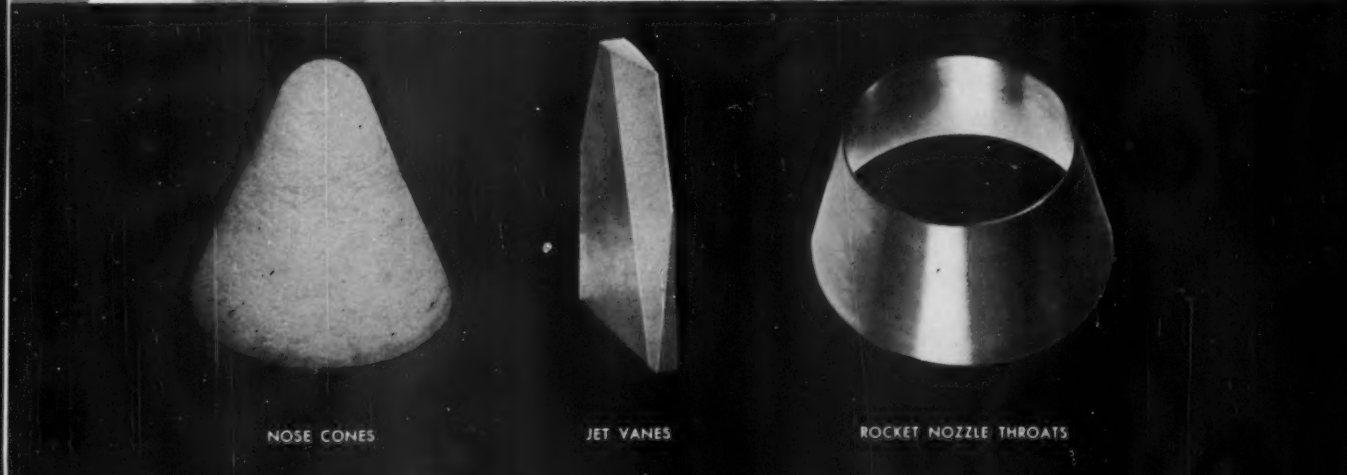

NOSE CONES

JET VANES

ROCKET NOZZLE THROATS

tolerance, the missile must remain in the tube. The standards of reliability designed into the missile are set high enough to make the probability of this acceptably low.

While Datico is not intended to provide a detailed check of individual components, a skilled operator can sometimes identify a fault below the replaceable module level by noting the amplitude of an out-of-tolerance reading, the way the reading varies with time, etc.

Ballhaus says it would be possible to give Datico the capability of checking the components of a system in complete detail if the missile umbilical were thicker and if a great increase in size, complexity and unreliability in the checkout equipment could be accepted. However, such a piece of equipment cannot be justified in the Polaris weapon system. Ballhaus likened the role of Polaris-Datico to that of a man checking the operation of a television set by watching the picture and listening to the sound. Without any equipment or skill he can decide whether the set is operating badly enough to call in a repair man. But to find a single bad component causing trouble calls for complex tools and a much higher degree of training.

Related Systems

Nortronics officials predict a widening market for the Datico and advanced checkout systems named Datimite and Daticomp. Datimite is a smaller checkout system using a larger percentage of solid-state circuits and designed for easier integration with digital computers. Daticomp will include computer elements and will come closer to the ideal of a universal checkout set. Some improvements learned in the advanced version programs are being fed into late model Daticos for Polaris.

Some of the features of more advanced Nortronics checkout systems which are being fed into the Datico improvement program include transistorized circuits, replacement of a mechanical punch tape reader by a photovoltaic one and replacement of stepper motors in the control system by switching diodes. One of the advantages sought in these changes is reduction in the noise level to make enemy detection more difficult.

Datico reflects Nortronics thinking on the subject of universal checkout equipment. A universal checkout would have been too large and complex at the time Datico was conceived because of the necessity of duplicating many components for the full inventory of missile, airplane and electronic systems. However, all system checkout sets must have certain features in common. They must be able to turn

Propellant Briefs from Callery Chemical Company

New fuel for Air Force by late summer—Callery is now modifying the Government-owned plant at Muskogee, Okla. to produce pentaborane under a new $9-million Air Force contract. Plant was originally built to produce high-energy boron fuels.

Pentaborane production begins late this summer for Air Force requirements only. At the outset, at least, no pentaborane will be available for commercial sales. Also worth noting: plant modification still maintains our capability for high-energy fuel production.

PENTABORANE (B_5H_9) Performance Data—Potential of pentaborane as a fuel is evident in its high heat of combustion—29,000 Btu/lb.—and its high specific impulse. Recent calculations yield the following shifting-equilibrium impulses for pentaborane:

Oxidizer	Is 1000/14 psia	Is 1000/.2 psia
OF_2	367	466
F_2	360	460
O_2	327	421
NF_3	326	413
H_2O_2	316	399
ClO_3F	306	391
N_2O_4	306	390
NO_2ClO_4*	302	389

*More about NO_2ClO_4, Nitronium Perchlorate, a new solid oxidizer, will appear in this column next month.

Pentaborane is soluble without reaction in saturated and aromatic hydrocarbons. May explode with oxygenated or halogenated compounds like acetone or carbon tetrachloride.

Pentaborane is compatible with all common metals, Saran, polyethylene, Kel-F, Viton A, asbestos, and graphite.

Write for Bulletin—Pentaborane C-1300.

Los Angeles office open for West Coast technical service — J. R. Perrin, new West Coast Representative for Callery, will serve fuel and propellant users in the Los Angeles area. His address is 17618 Ventura Boulevard, Encino, California. Telephone: State 4-9328.

In the Washington, D.C. area, contact Richard A. Carpenter, Room 709, DuPont Circle Building, 1346 Connecticut Avenue, N.W., ADams 4-4200.

For information or technical service: write Defense Products Dept., Callery Chemical Company, P.O. Box 11145, Pittsburgh 37, Penna.

Mr. J. R. Perrin
Manager, Western District
Defense Products Department
Callery Chemical Company

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BEST WAY TO SEAL HOLES!
LEE PLUG
Simply place plug in reamed hole. Drive in tapered pin until ends are flush. Controlled expansion causes grooves to "bite" into casting, assures a bone dry seal that withstands pressures up to 40,000 psi. Now widely used on aircraft and missiles, and for pumps, servo valves, regulators, etc.
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PLUG
inserts by hand
REAMED DRILL HOLE
your castings
LEE COMPANY
OLD SAYBROOK, CONN.
WRITE TODAY FOR COMPLETE ENGINEERING DATA

PROBLEMATICAL RECREATIONS 24

A gambler devised a game to be played with a friend. He bet ½ the money in his pocket on the toss of a coin; heads he won, tails he lost. The coin was tossed and the money handed over. The offer was repeated and the game continued. Each time the bet was for ½ the money then in his possession. Eventually the number of times he lost was equal to the number of times he won. Quickly now! Did he gain, lose, or break even? —*Pacific Electronics Monthly*

It is about time that we told you about our research group in San Carlos, California. This group is a rather powerful capability for the advancement of knowledge in electron physics. And in our adjacent San Carlos manufacturing facility they can find out in a hurry whether theory can be translated into hardware.

ANSWER TO LAST WEEK'S PROBLEM: If the conclusion were not valid, then every tree would have a different number of leaves; and you'd run out of leaves before you ran out of trees. It's valid.

LITTON INDUSTRIES
Beverly Hills, California

equipment on and off, feed control signals to the system, measure its response against selected criteria, and report the results of the comparison to its operator. The Datico idea was to build a set having these features and then custom-engineer the elements which must be peculiar to the system being tested.

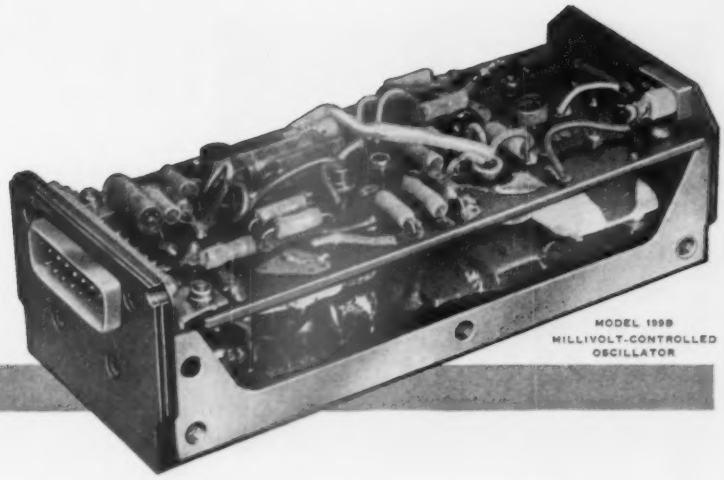
A universal problem in the design of checkout equipment is that of determining whether a malfunction indication is produced by a failure in the system being tested or in the checkout set itself. To some extent, self-checking features can be designed into the set, but Nortronics engineers regard this as a luxury item bringing with it additional complexity and a certain amount of additional unreliability. In Datico-Polaris, it is used only in the digital multimeter and in test signal sources. To evaluate the functioning of the complete Datico, Navy crews will be able to run taped self-varification exercises with missiles switched out of the checkout loop.

Modified for Submarines

Nortronics drew on the experience of Naval Electronics Laboratory, San Diego, for help in modifying Datico for use aboard submarines. NEL has collected much information on the stresses placed upon electronics at sea. Following NEL recommendations, Nortronics has required electronic components and modules to withstand 25g shock loads. The massive enclosure of the Datico equipment racks is designed for 50g shock loads and 10-33 cps. vibrations. Its three bays of modules are wired together through quick disconnect fittings so the bays can be passed through narrow hatches singly to be installed in the boat. Coolant air for the electronic equipment is passed through the double walls of the enclosure.

The mounting of the enclosure is made flexible to let it compensate for the straining of the ship's structure under sea loads. When submerged, compression of the hull by sea pressure can cause the soft deck in the missile control center to move up or down as much as two inches. The enclosure is suspended from double hinges on the bulkhead above it to allow the enclosure to move and tip without being crushed or ripped apart by the motion of the ship. Flexible mounting is also some protection against damage to equipment by the shock of detonating depth charges.

Each Polaris-carrying submarine will have two Datico sets installed in the missile control center. Either one can check all the missiles or they can be divided for speed. The arrangement also allows the operator to switch sets to determine whether a malfunction



MODEL 199B
MILLIVOLT-CONTROLLED
OSCILLATOR

TWO NEW VOLTAGE-CONTROLLED

SUBCARRIER OSCILLATORS

For High-Level or Millivolt Signals

When millions of dollars ride on a single missile flight, precision instruments are necessary to assure accurate, reliable data. In FM telemetering systems **e·m·r** subcarrier oscillators are well known as precision instruments. They are not equalled in linearity; intelligence frequency response and fidelity; efficient signal translation power gain; and stability of all characteristics under aircraft or missile flight conditions.

Two new voltage-controlled subcarrier oscillators now available from **e·m·r** are the Models 184C and 199B. The 199B millivolt oscillator deviates full bandwidth with ±10MV into a floating, balanced, resistive input. Common mode rejection is typically 120DB at DC and over 70DB to ⅓ the carrier frequency.

The Model 184C is a rugged, precision subcarrier oscillator, packaged in a hermetically sealed 1½" cube. It converts high-level signals of +3, +5, −5, or ±½ volt into an FM subcarrier signal with a conversion linearity of 0.1%. For rugged, accurate, stable subcarrier oscillators for any application contact **e·m·r**.

CONDENSED SPECIFICATIONS

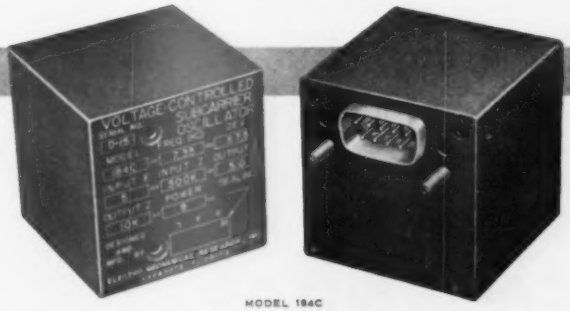
184C

Input: ±2.5 Volts; or 0 to +3 or +5 Volts
Output: Any preset value up to 5 Volts rms into 5K load; or adjustable into 47K load
Linearity: ±0.1% of best straight line for ±7.5% deviation
Stability: Less than ±1% drift in 24 hrs. after 3 second warmup
Input Impedance: 500,000 ohms, resistive
Size: 1½" Cube
IRIG Channels: 1-18 and A-E

199B

Input: ±10 millivolt for full deviation
Output: Any preset value up to 5 Volts rms into 5K load
Linearity: ±0.2% of best straight line for ±7.5% deviation
Stability: Less than ±1% drift in 8 hrs. after 3 second warmup
Input Impedance: 2,000 ohms; stable within ±1% under all conditions
Size: 1.25" x 4.4" x 1.85"
IRIG Channels: 7-14 and A
Model 199B available with over 50,000 ohm input resistance, stable within ±5% under all environments; gives full deviation from ±20MV signal

For complete information contact:



MODEL 184C
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- **Four-cycle Premium Performance . . . at No Premium in Price**
- **Excellent Service Life**
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- **New Compactness**
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- **Exceptional Fuel Tolerance**
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- **Power-output Ratings Are Realistic, Horsepower or Kilowatt Certification on Request**
- **Available in Industrial, Marine or Electric Set Configurations**

For complete performance specifications on these new Caterpillar Diesels or on the complete line, see your Caterpillar Dealer. Or, write to Engine Division, Caterpillar Tractor Co., Peoria, Illinois, U. S. A. Ask for the catalog on the complete Caterpillar Engine line.

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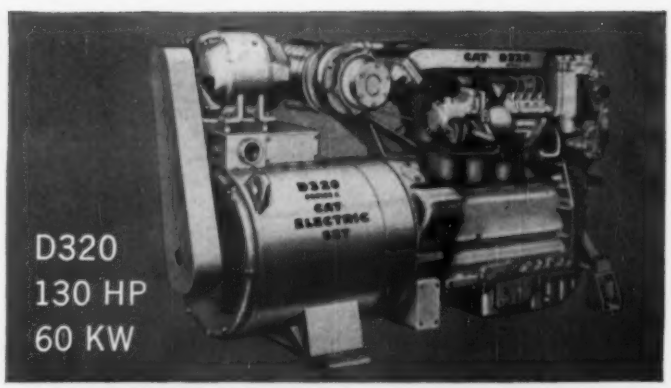

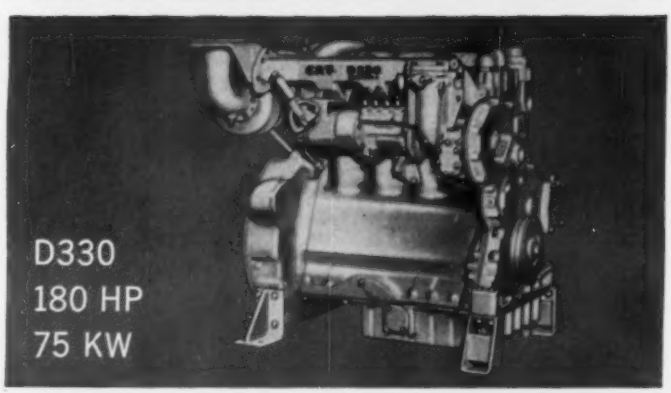

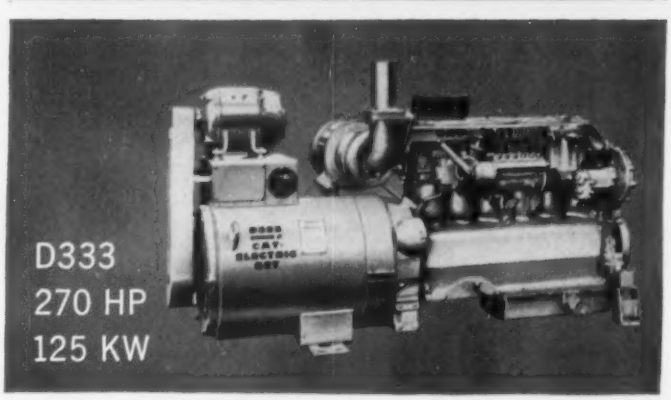

signal is being caused by the missile or the checkout set.

The basic Datico consists of a programmer-timer with an integral punched-tape reader, control scanner, program board module, test point selector, digitizer, comparator, indicator and control, tape magazine and printer. It commands service equipment specially adapted to Polaris to generate preselected test signals and other service equipment measures the output of missile subsystems for comparison by the basic set.

Three Levels of Use

Datico-Polaris has three levels of use —watch mode, test mode and operate mode.

- **Watch mode** is a continuous monitoring of aspects of the missile system which could involve hazard to the boat as well as the monitoring of the readiness of critical missile and warhead circuits.
- **Test mode** is the periodic maintenance check to make sure the launch and flight control systems are ready to function properly.
- **Operate mode** is the final count-down check made under pressure of time.

The watch mode begins when the first missile comes aboard and remains in effect continuously with a technically qualified man always on duty at the display panel. Datico is connected to the various subsystems of each missile through the fire control switchboard. Watch mode measurements are displayed on a separate panel. Part of the panel is used to report on special hazardous circuits in each missile including:

- **Safe ready switch** position.
- **Warhead arming-fuzing.**
- **Igniters and first stage** separation charges.

Eleven environmental factors are monitored in the other half of the watch mode display panel:

- **Guidance temperature.**
- **Guidance coolant flow.**
- **Internal pressure** of solid propellant motors.
- **Tube humidity.**
- **Tube coolant flow.**
- **Spare guidance capsule** temperature.
- **Spare guidance capsule** coolant flow.
- **Header** (annulus around Launcher tube) temperature high.
- **Header temperature** low.
- **Air sampler** to detect hazardous nuclear radiation products.
- **Launch tube temperature.**

Some of the environmental factors are not associated directly with the missiles. In these cases a No-Go condition in the circuits responsible for these factors will sound an alarm and turn on a malfunction indicator without placing a missile on a No-Go status. After launch of a missile, an action

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ENGINEERING
REPORT
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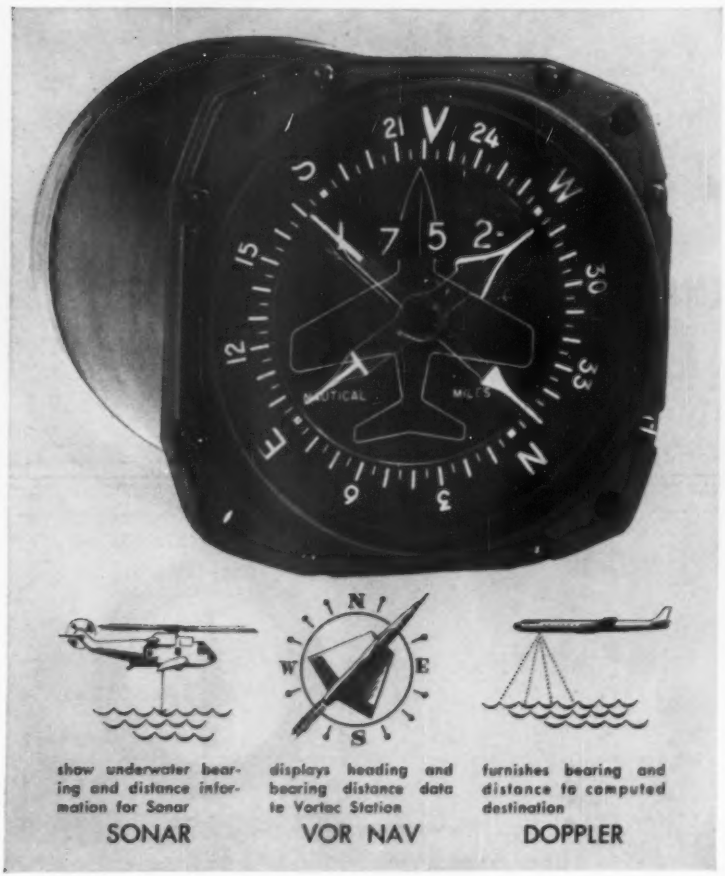

show underwater bearing and distance information for Sonar

SONAR

displays heading and bearing distance data to Vortac Station

VOR NAV

furnishes bearing and distance to computed destination

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Compact Bendix Indicators with wide application range

Eclipse-Pioneer is long-experienced in the design, engineering, and production of lightweight, compact, versatile navigation instrumentation to meet both today's and tomorrow's needs.

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cut-off signal is automatically sent from fire control to inactivate the display for that missile.

Procedure for the conduct of test mode operation will require the operator to use a precut taped program to prevent ill-informed innovations. The tape cannot be changed in the boat.

When a reading in the test mode is out of tolerance, the test program is halted at that point. A measurement repeat button can be pressed to double check the out-of-tolerance reading. If the reading is marginally out of tolerance, the fire control supervisor can order the operator to push an override button. This can be used to continue the test to search for effects related to the out-of-tolerance condition. If the measurement repeat control causes a later reading to indicate "Go," the taped progress of the test program will continue automatically, unless the Datico is placed under manual control to prevent it.

While operating in the test mode, Datico performs these three system loop tests:

• **Flight control loop gain** check is made with the stable platform gimbals caged at zero, the guidance computer off, rate gyro excitation windings grounded. Datico bypasses all other subsystems in the submarine and the missile under test and supplies a signal simulating that of the inoperative guidance capsule. The loop gain is obtained by measuring the feedback voltages from the jetevator potentiometers, amplifying them and comparing them with limits or tolerances programed on the tape. An in or out of tolerance condition is then signaled and the actual value of the comparison is printed on a read-out tape for a permanent record.

• **Guidance computer-flight control** loop is performed with the stable platform gimbals caged at zero and rate gyros squelched. Fire control initiates three reversals of the flight control stepped motors, which are to come to a stop in an indexed position. Only one channel (pitch or yaw) of each stage is exercised in the test. Jetevator potentiometer feedback provides the test signal for comparison with tape values.

• **Stable platform-flight control** loop is tested with the guidance computer out of action, the flight control system stepper motors indexed to zero. Stable platform-flight control loop gain is checked by caging the stable platform pitch, roll and yaw gimbals separately and at predetermined angles. With the gimbals caged at a known angle, jetevator deflection is measured to see if the control response is within tolerances.

Also checked are hydraulic pressure, fluid level, and fluid temperature.

KIWI-A prime reactor experiment involved barrel-shaped device, about 5 ft. high and 5 ft. in diameter, with a radioactive core of uranium-235. Hydrogen gas, heated to thousands of degrees, was discharged into the atmosphere through a nozzle.

AEC Fires Kiwi-A Prime Reactor System Under High Heat State

Jackass Flats, Nev.—A power run of Kiwi-A prime, a nuclear reactor system in the Rover program to demonstrate the feasibility of nuclear rocket propulsion, has been conducted at this test site. In the experiment, hydrogen gas flowed through the reactor system for several minutes under conditions of extreme heat.

The Rover nuclear rocket program is being operated jointly by the Atomic Energy Commission and the National Aeronautics and Space Administration (AW June 6, p. 102).

Scientists of the Los Alamos Scientific Laboratory, which is conducting research and development in the nuclear reactor development phase of the program, declared after the one-hour run that instrument readings indicated that the test was conducted as scheduled, but that final reports would have to await examination of the reactor.

Following the experiment, the reactor was taken on the remotely controlled railway car on which it is mounted, to a nearby maintenance building for disassembly and examination.

Several hour runs, at various levels of nuclear heat within the reactor, are scheduled for later this summer with Kiwi-A 3, the reactor system similar to Kiwi-A prime.

ENGINEERING
REPORT
ON OTHER BENDIX
COMPONENT PACKAGES

GEAR HEADS

Compact units that provide output motor speed reductions.

These easily detachable heads are available in various frame sizes, and supply reductions in ratios ranging from 7.22:1 to 42,471.90:1. Ball bearings are Class A. B. E. C. 5, or better, and gears are cut to AGMA Precision II tolerances, or better, with backlash held to 30 minutes, or better. Adaptable to variety of motors and motor generators. Write for details.

½-INCH LOW INERTIA MOTOR

Designed for instant response in servo systems.

The CK-1066-40-A1 Bendix low inertia motor is a two-phase, four-pole, 400-cycle induction type and is one of the smallest motors available for servo systems. Measures only 0.50″ in diameter and $1\frac{19}{64}$″ in length. Unit consists of a squirrel-cage rotor that rotates on precision ball bearings, a two-phase stator, and a stainless steel housing. Standard motor has tapered shaft, but units can be obtained with other type shafts and with center-tapped control windings.

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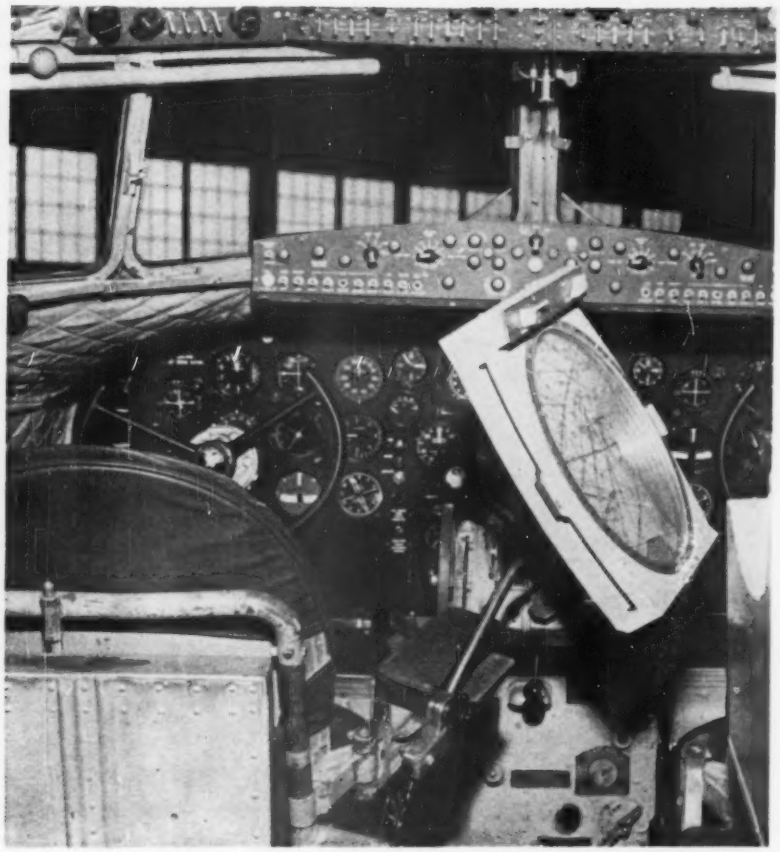
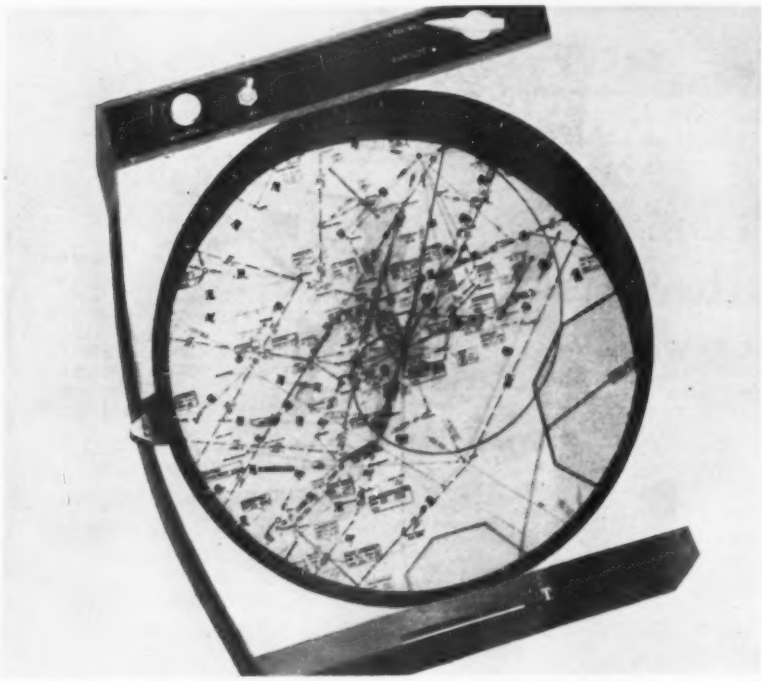
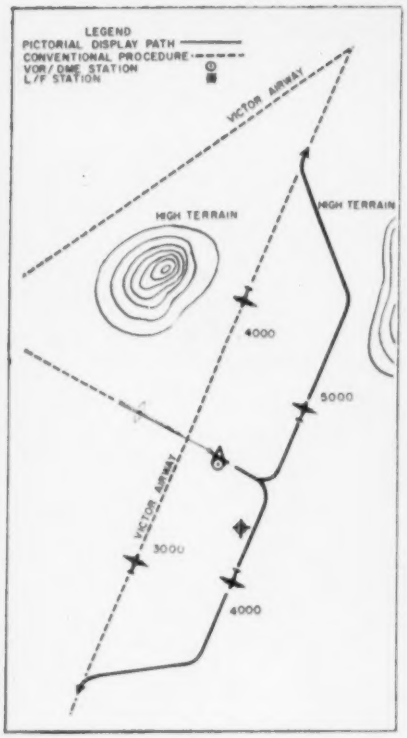


ITT LABORATORIES pictorial display is shown mounted in the cockpit of the company's Douglas DC-3. The device may be swiveled about for viewing by pilot or copilot. The ITT display measures 15 x 13 in. and weighs 13 lb.



ITT DISPLAY indicates aircraft position by intersection of spiral and radial lines inscribed on rotating acrylic disks. Idlewild map, above, indicates aircraft position to the east of Wilton VOR station.



TYPICAL APPLICATION proposed for routing IFR traffic shows departure track paralleling arrival airway to expedite departures.

FAA Studies

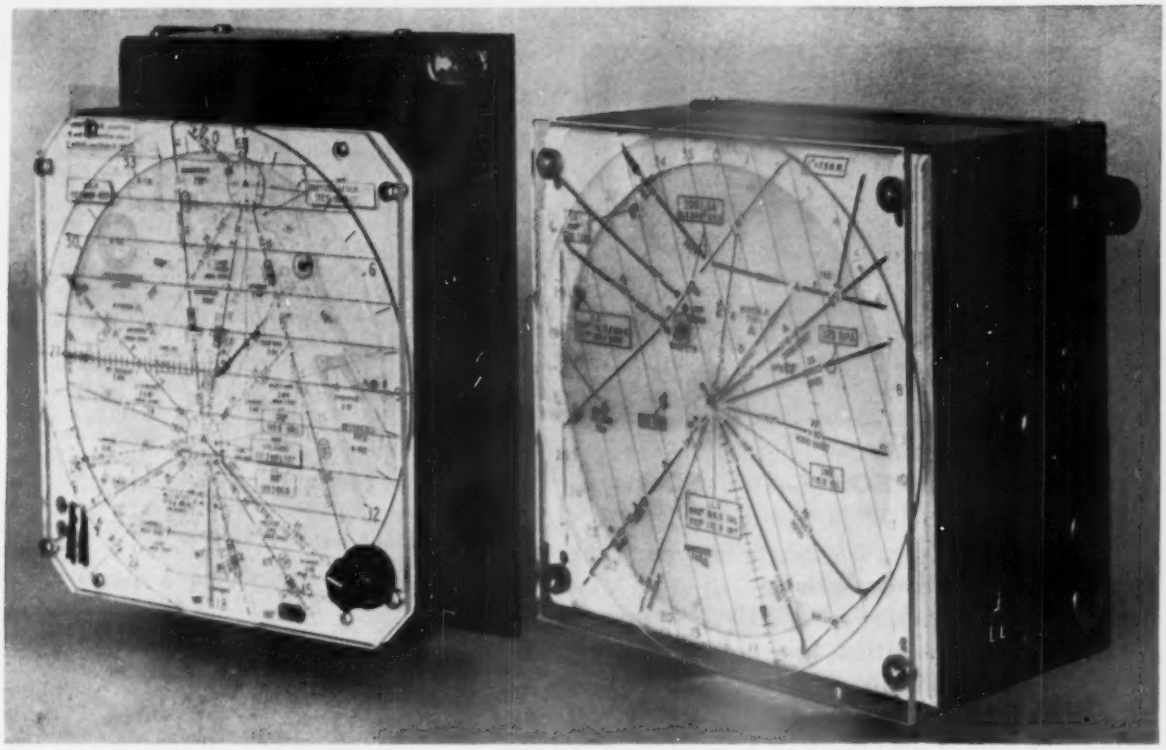
By Barry Tully

New York—Pictorial navigation displays, derived from Vortac inputs, will be offered to civil aviation this fall.

The estimated cost of the display instruments, which provide continuous geographical position information during flight, is about $2,500. One such display device, produced by ACF Electronics, Paramus, N. J., was demonstrated in flight to AVIATION WEEK.

Initially, the map displays will serve as an additional cockpit navigational instrument and as an aid in reducing pilot/controller communications in terminal areas. The display devices will pay off, however, when the Federal Aviation Agency approves off-airways routing incorporating parallel and offset courses for aircraft equipped with the instruments. This will facilitate arrivals and departures at terminal areas and generally increase airspace capacity by providing lateral as well as vertical separation.

The FAA, using various pictorial display devices, is conducting a program to develop approach, departure and en route procedures for aircraft equipped with the display instruments. The program, conducted at the FAA's experimental center at Atlantic City, N. J.,



ACF ELECTRONICS is developing pictorial displays to use individual map slides, left, or rolls containing 80 map frames. Aircraft geographical position is indicated by means of a circular reticle, which moves beneath the map slide. Parallel lines marked on circular index are used to determine off-airways courses. Maps for the ACF display are produced by Jeppesen & Co.

Pictorial Navigation Displays for Civil Use

will continue through August, 1962.

Renewed interest in Vortac derived pictorial display devices, undoubtedly stimulated by the VOR/Decca controversy, is causing several avionics firms to dust off devices which have been designed over the last 13 years for various military and CAA proposals. The electronics of the rho-theta input pictorial displays requires no breakthroughs, however the problem of presentation, including necessary map information, scale and display size, has proved thorny.

The importance of the rho-theta pictorial display systems is that they make optimum use of what will be the U.S. primary air navigational system, Vortac. Under VOR and Tacan systems as now used, aircraft receive precise guidance information only along designated radials despite the fact that the signals are propagated throughout the entire signal area. The display indicators tend to bridge the gap between instrument and visual contact flight. Operational use of the indicators will permit more efficient use of the airspace about terminal areas, thus alleviating some of the pressure caused by increasing traffic density and increasing disparity in airspeeds.

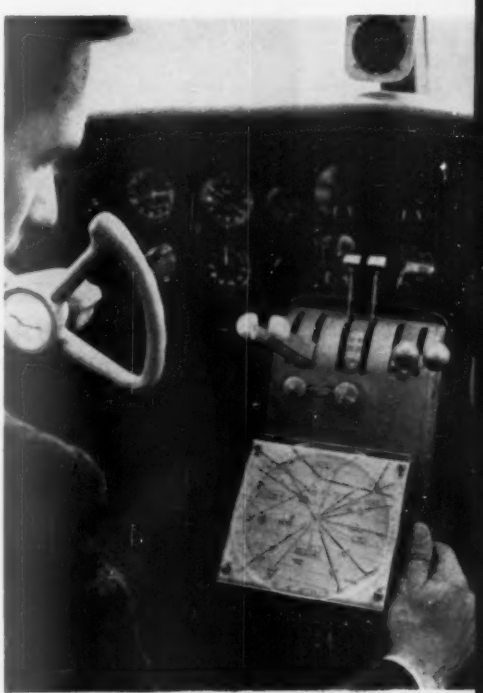
The program conducted by the FAA at its National Aviation Facilities Experimental Center, Atlantic City, N. J., (AW Mar. 21, p. 70) is intended to develop procedures which will best utilize the pictorial displays.

Aircraft employed in the program include a Convair C-131 and a Grumman Gulfstream. Jet data will be acquired with either a Lockheed JetStar or a Douglas A3D at a future date. The FAA is not evaluating the pictorial displays individually, but is attempting to determine what air traffic control innovations will result from their use.

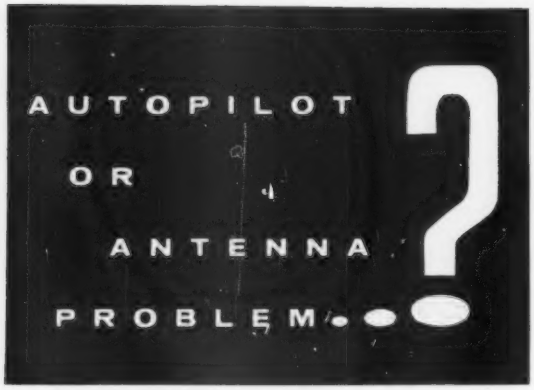
NAFEC Program Devices

Included among the pictorial display devices being employed in the NAFEC program are:

- **ACF Electronics** device demonstrated to AVIATION WEEK.
- **FAA-developed device** being used in the program that represents the aircraft position by a spot of light which moves about in relation to a Vortac station. This display, also a lap model, measures 9 x 9 in.
- **ITT Laboratories,** Nutley, N. J., has developed a commercial pictorial display which it will send to NAFEC. In this display, bearing is a function of the rotation of a radial line, and distance is a function of the rotation of a spiral line. The aircraft position is repre-



ACF DISPLAY, mounted in the company's Aero Commander 520, can be viewed from left or right seat or held on the pilot's lap.



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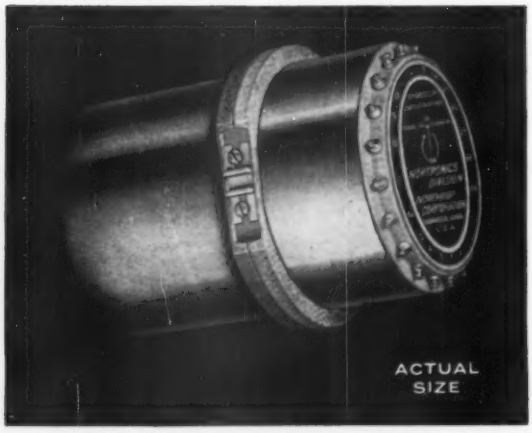

← GI-H5 miniature integrating gyro
Size ←
Cost ←
Perf →

MEASURED CHARACTERISTICS **1.** Total Drift: less than 5°/hour (uncompensated), less than 4°/hour per G. **2.** Storage Temperature: −65°F to +200°F (higher temperature models available). **3.** Extremely stable thermally, with warm-up time to 5% of damping from −65°F within 7 minutes. **4.** Characteristic Time Constant for 6 degree memory angle unit = 0.87 milliseconds. **5.** P.M. Torquer with better than 0.05% linearity and 1 rad/sec peak steady-state torque. Unpack it, put it in the system — it's ready to go. Availability — 90 days. Write or TWX for detailed test data on the GI-H5 (Norwood 835-U, or field offices listed below).

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sented by the moving intersection of the two lines which are inscribed on translucent acrylic disks.

The ITT display has two scales, one called terminal area scale which represents a map diameter of 96 naut. mi., and en route scale displaying a 390 naut. mi.-diameter map. This pictorial display measures 15 x 13 x 2 in.

• **Sperry Gyroscope Co.,** Great Neck, N. Y., also will supply a pictorial display device for the NAFEC program. This will be based on the company's doppler input ATN-118 display developed for the Army. This display device also will represent geographical position with a spot of light. The display surface will measure 11 x 13 in.

Other avionic firms planning to market pictorial displays for civil aircraft include Arma Division of American Bosch Arma, Bendix and Collins. The devices, most of which stem from military designs, may be built to widely varying degrees of sophistication.

ATC Applications

Among the air traffic control applications for routing of aircraft equipped with pictorial display systems are:

• **Parallel departure tracks** for lateral separation would minimize ground delay by permitting parallel flight paths.

• **Straight-in approaches** to all runways would be possible with the pictorial displays. Pilots could follow approach plate paths which would permit the straight-in approaches.

• **Lower minimum altitudes** would be possible in that buffer areas could be reduced.

• **Discrete climb and descent** paths for aircraft of varying speeds would be of particular benefit to jet aircraft.

Flight Evaluation

The flight evaluation of the ACF Electronics pictorial display instrument took place in the company's Aero Commander 520. Upon climbout from Teterboro Airport, N. J., the aircraft's Tacan was turned on and the display indicator connected. ACF's engineering test instrument was operating from Tacan inputs rather than from VOR/DME/T due to the paucity of operating Vortac stations when the program began.

The 6 x 6 in. unit can be held in the pilot's lap or, in this particular aircraft, could be mounted on an emergency pump handle between the pilot and copilot seats. Just where to put the display poses something of a problem as it must be easily seen by the pilot, yet one gets tired of holding it in the lap. On jet transport aircraft, holding the pictorial display could become a third pilot function.

The Idlewild map was inserted for the 15 n.m./in. range scale and the moving reticle positioned itself on our loca-

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SPLIT—SECOND INFORMATION

An effective Army must have split-second, exact combat intelligence. Republic's Missile Systems Division is working on one means of fulfilling this need for the U. S. Army with the AN/USD-4 Swallow system: a completely integrated ground-airborne information-gathering system.

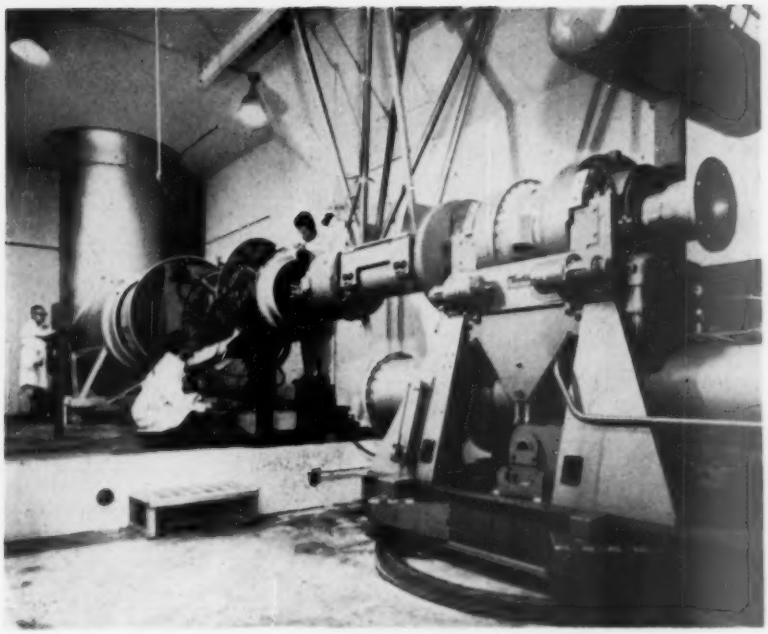
The SD-4 system includes an all-weather, jet-powered surveillance drone, mobile ground command and information stations, and associated ground support equipment. The drone will be field-launched and employs any of a number of surveillance sensors. This high-performance unit will permit the field army commander to extend his view beyond the horizon to gain up-to-the-minute information. Its mission completed, the SD-4 will return, be recovered and readied for a new mission.

The airborne-ground SD-4 Swallow system was designed and is being developed by Republic's Missile Systems Division under contract to the U. S. Army Signal Corps.

REPUBLIC AVIATION

MISSILE SYSTEMS DIVISION

MINEOLA, LONG ISLAND, N. Y.



PacAero Turboprop Engine Test Facility

New turboprop engine test facility at Pacific Airmotive Corp., Burbank, Calif., features a Clayton dynamometer which will handle both U. S. and British engines of up to 6,000 shp. Above, an overhauled Rolls-Royce Dart RDa.6 engine has been tested through entire operating cycle. Company says the dynamometer accuracy is better than one half of 1% of the observed reading. Instrumentation is located in a separate room.

tion near Newark, N. J. The weather was VFR with about 8 mi. in haze; however, flight was made at 5,500 ft. and higher altitudes due to high density traffic.

Initially, we homed on the Idlewild Tacan on an off-airways heading of 120 deg., the reticle faithfully following our course. Close-in to the station, the pictorial display will register the same distance error due to height as all distance measuring equipment. Upon reaching the Idlewild Tacan, the reticle indicated this by drifting in a tight circle about the Tacan station in the center of the display.

Proceeding on course, however, the pip oriented itself and began tracking us outbound.

The ACF RT-1 display demonstrated to AVIATION WEEK did not have the "off" warning flag which will be incorporated on production models. The equipment did indicate loss of azimuth inputs by drifting in a circle about the center of the display. Loss of distance signals caused the reticle to search along the full length of the radial track.

The display permitted time distance checks of groundspeed when flying off airways. This is accomplished by flying a heading and timing the pip over a known distance on the map. Wind drift also is readily discernible even when flying off-radial courses.

It seemed to this pilot, that to best utilize pictorial display instrument, one should fly his directional gyro and use his display as a constant check of his position. The pilot who is new to the devices may become fascinated by the little bug only to find his heading has drifted considerably long before an off course movement of the reticle can be detected.

In-Flight Test

Flying over Mitchel AFB, I selected the 7.5 mi. scale on the Tacan, switched to the appropriate map and turned to a direct heading to La Guardia Airport. A manually rotated index on the display is used to determine off-airways courses. The index wheel, similar to an old-style plotting board, is used to line up the reticle with the destination. Course is read from compass rose on the periphery of the wheel.

The heading to La Guardia from Mitchel was 305 deg. Maintaining this heading with occasional corrections as the bug drifted off course to the right, the 13 n.m. was flown. The reticle moved on course to a position above La Guardia Runway 31 (clearly marked on the 7.5 n.m. in. scale map), whereupon a visual check verified our position directly over the runway.

This is not to imply that the pictorial display equipment may be used to shoot a precision approach to a runway, nor is any company planning to market the devices for this purpose. Inherent rho-theta system errors preclude the use of

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Honeywell's Aero Division now offers a competent, versatile service in the field of instrument repair and overhaul. This service is handled in Honeywell Aero's separate Repair and Overhaul facility and is available to commercial as well as military organizations. Most noteworthy feature is the economical and quick turnaround of repaired devices. Close control throughout the repair cycle results in consistent meeting of scheduled deliveries. Skilled personnel are well qualified to repair and overhaul even the most complex of missile guidance systems.

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For free brochure with complete details, write: Minneapolis-Honeywell, Aero Division, P. O. Box 330, 2600 Ridgway Road, Minneapolis 40, Minnesota.

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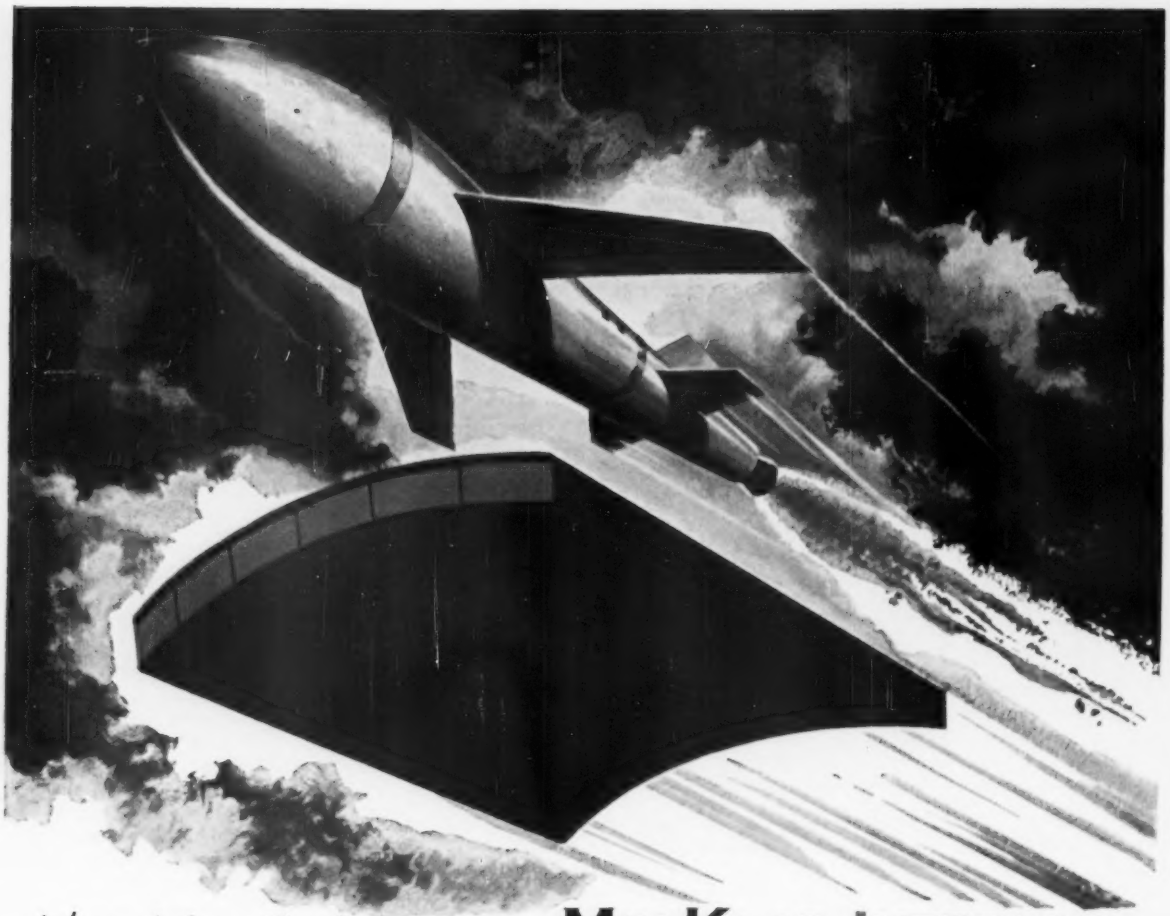
Military Products Group



Johns-Manville Announces... MIN-KLAD INTERLOK

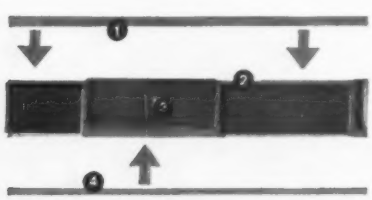
. . . a new structural system interlocking Min-K insulation and high-temperature reinforced plastic

Missile experience shows that in certain heat control situations no one material will perform as well as two (or more)—*an insulation with protective high-temperature facings.*

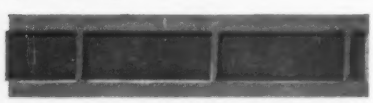
Problem is how to effectively combine these materials into a structurally strong unit? The answer is Min-Klad Interlok —a new structural system that interlocks Min-K insulation and reinforced plastic, metal or other high-temperature facings.

The result: one product that gives the missile designer every advantage of high-temperature plastic or metal foil—strength, toughness, rigidity! Erosion resistance! High heat capacity!

. . . plus the outstanding advantages of Min-K insulation—an insulating core that has the lowest thermal conductivity available for service temperatures up to 2000°F steady-state, and higher for transients. Min-K's thermal conductivity is actually lower than the molecular conductivity of still air.



1) Outer facing, 2) Interlocking web, 3) Core, any one of several Min-K formulations, and 4) Inner facing.



All the above components combine to provide a custom-made structural strong insulating system.

Wide range of facings

For the hot face, the missile designer can specify Min-Klad Interlok in a wide variety of heat-resistant and/or ablating materials—asbestos-phenolic (ARP-40), and similar reinforced plastics, as well as stainless steel and other heat-resistant metal foils and meshes. For some requirements, the cool face can be made of a different material—for example, one that offers characteristics required for bonding or fastening to other surfaces and parts.

Like all J-M Aviation insulations, Min-Klad Interlok is factory-fabricated to your specifications into external skin panels, heat shields, cylindrical liners or component housings of any shape or size. Write today for technical specifications. Address Johns-Manville, Box 14, New York 16, New York. In Canada, Port Credit, Ontario.

JOHNS-MANVILLE JM PRODUCTS

the displays for low visibility approaches. Additionally, ACF says that its display (based on ideal inputs) will be accurate to 1/32 in. This means a possible error of .2 mi. (1,200 ft.) on low ranges, hardly precise enough for a low approach. The pictorial displays will prove of value as a positional check during VOR and radar approaches and during missed approach procedures.

Holding Pattern Ease

One important advantage of the pictorial displays will be the ease in which a pilot may adhere to a holding pattern. To check this a simulated holding pattern was drawn on the surface of the display and flown with little difficulty. Following this a random curved line was traced on the display surface and followed. At first, it is difficult to stay precisely on the curved line, but the advantage of the equipment is that the pilot instantly recognizes when he is off course and the necessary correction is obvious.

The ACF Electronics display system, designated RT-1, is a transistorized, 6 in. square unit requiring only electrical connection to VOR/DMET or Tacan equipment. To operate the unit a map printed on transparent material is inserted beneath the acrylic plastic surface. The maps are coded to automatically shift the equipment to the correct scale upon insertion. Scales offered on initial production models will be 10, 20, and 48 n.m./in.

Beneath the map a slotted plastic disk rotates so that the rotating axis is beneath the Vortac station in the center of the map. Servoamplifiers in the unit rotate the disk in response to azimuth inputs and move the reticle (on a rack and pinion) along the radial slot in response to distance inputs from the DMET transponder.

In this manner the servo instrument tracks the aircraft position about the map.

The display presents no pen trace informing the pilot where he has been, nor does it present heading information. This can be approximated, of course, by estimating the bug's track.

ACF Models

ACF Electronics will produce its pictorial displays in several models; the RT-1 will incorporate roll maps with a capacity of 80 frames per roll. The unit also will handle individual map slides. The RT-1B, described above, will handle only map slides eliminating some of the bulk and the slew motor to drive the map rolls. Both models employ Arinc AT 1-6 cases. The larger RT-1 model measures 6¼ x 6¼ x 3½ in. and weighs 4½ lb. The 3½ lb. RT-1B measures 6¼ x 6¼ x 2 in.

Equipment needed to operate the ACF pictorial display is a VOR receiver,

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Eyes of SAC, by Raytheon

Raytheon radar capability flies with the Convair B-58 Hustler, helping point the way at speed Mach 2-plus and altitude X.

Accurate, long-range eyes, this search radar-and-radome by Raytheon, as subcontractor to Sperry Gyroscope Co., is the most sophisticated in the world today, and marks Raytheon as the first electronics company to integrate radar and radome development for a high-performance aircraft. Other Raytheon airborne radars include B-58's Doppler Radar and Boeing B-52's Search Radar.

To date, over 1000 Raytheon radars have been delivered to our Strategic Air Command.

Raytheon's *systems* approach to cooling, weight and package problems assures that this equipment meets or exceeds the most advanced requirements for operational performance and reliability.

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For Airborne Radar Brochure,
Write: Director of Marketing, Equipment Division, Dept. D1, Raytheon Company, West Newton, Mass.

Convair B-58 to Be Flying Testbed for J93 Turbojet

Specially designed pod which will carry a General Electric J93 turbojet engine (powerplant for the North American B-70 Mach 3 bomber) is installed on the belly of a Convair B-58 Hustler prior to fitting (AW July 18, p. 75). Engine will be flight-tested in this configuration to investigate air starts, transient control and afterburning; it also will be used to test ground handling characteristics. In flight, with the J93 operating, the B-58's four J79s would be throttled back from normal cruise power settings.

a DMET transponder and a Radio Magnetic Indicator. The power requirement is that required to operate the DMET, 26 v.a.c. 400 cps.

ACF says that (assuming ideal inputs) the position accuracy of the display is $\frac{1}{32}$ in.

Equipment Modification

The usual fail-safe "off" warning flag and red back light accouterments for night use are provided. ACF says that the equipment can be modified to provide an XY display operating from doppler navigator inputs.

This is true of most of the pictorial display devices.

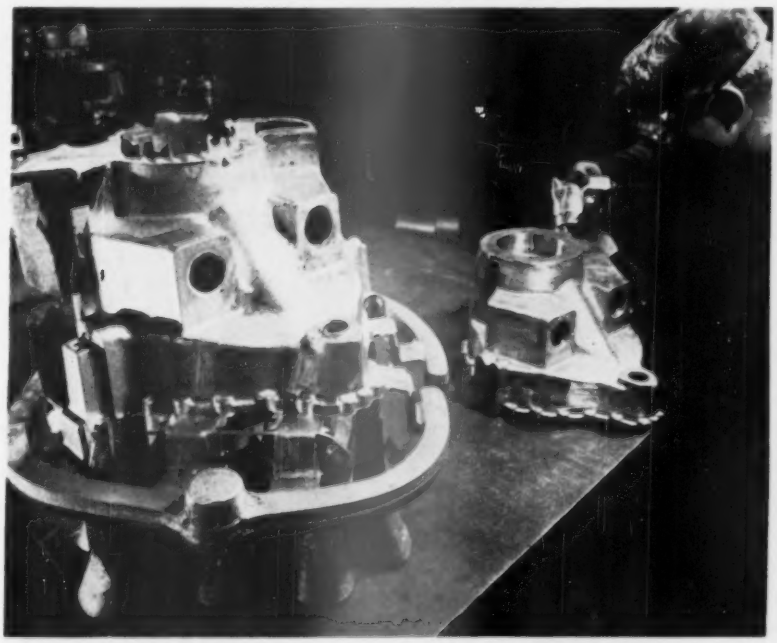
The maps used in the ACF pictorial display are produced for ACF by Jeppesen & Co., Denver, Colo. Just what information to include on the maps has proved a problem to ACF. The maps will not replace standard navigation charts, so therefore they need not include all the information. Pan American is testing the ACF display and their pilot's comments will determine this information.

Navy Contracts For Terrier-Tartar Devices

Automatic checkout equipment for Convair Terrier-Tartar family of missiles is being produced at Hycon Mfg. Co., Pasadena, Calif., under $6 million Navy contract. Equipment was developed under direction of Navy Bureau of Weapons and John Hopkins University's Applied Physics Laboratory, is designed to perform complete missile checkout in three minutes, according to Hycon President Trevor Gardner. Green and red lights indicate functioning or faulty missile, respectively, and test equipment also indicates specific defective system.

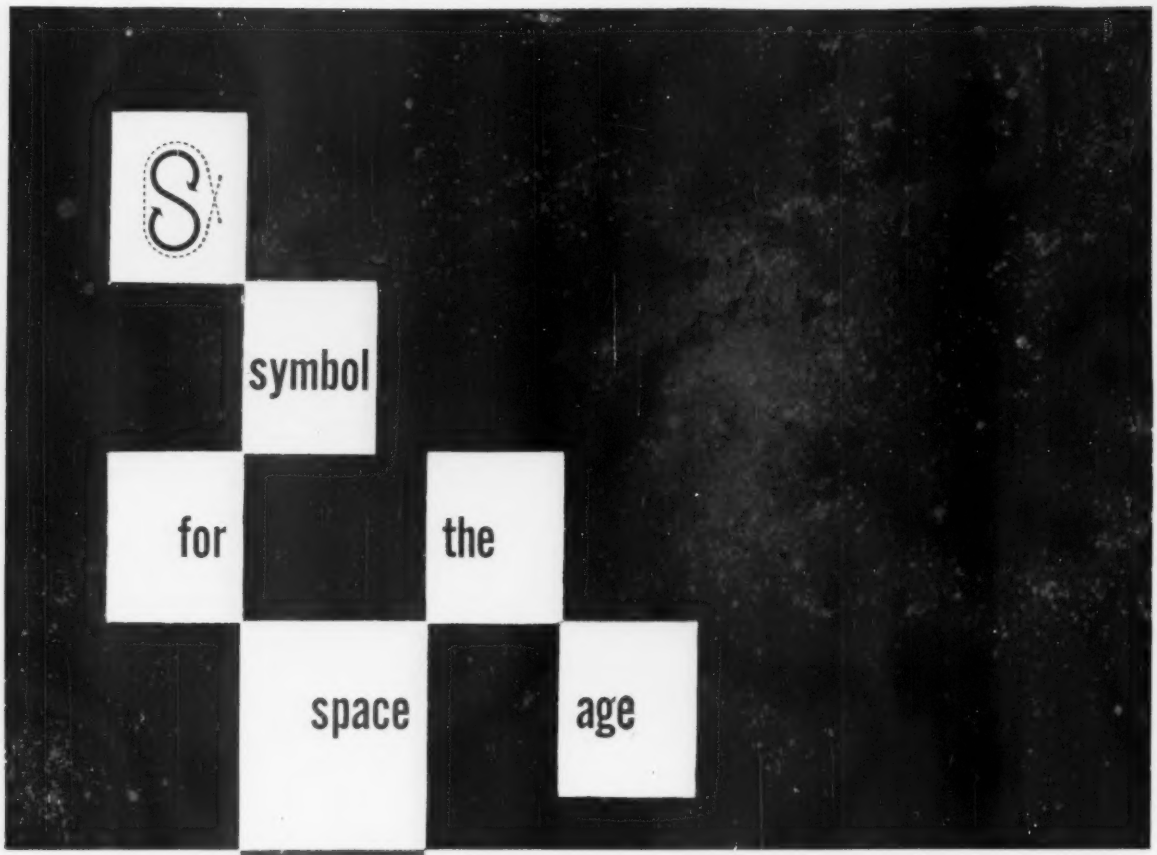
Interchange of plug-in modules permits the same basic test set to check out six different missiles in the Terrier-Tartar group.

Production under the Navy contract will be started in the company's Pasadena facilities, then transferred to a new 9½-acre facility in Monrovia, Calif. Hycon's backlog now is about $9 million, highest in company's 10-year history.

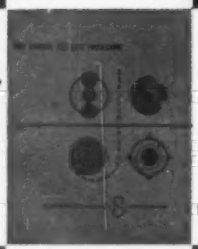


Boeing Produces Small-Turbine Castings

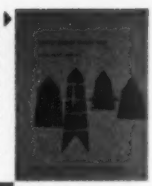
Aluminum castings above are for reduction unit output housings for Boeing Industrial Products Division's 400-shp. small gas turbine engines. Casting at left has been removed from molding sand; gating system is still attached. Casting at right is being trimmed. Internal configuration of the casting requires nine cores in the molding process.



Test control and data processing systems used for rocket and missile testing and designed as a single concept... Bulletin 3022-X8.



Automatic data recording and processing system now being used in tests of the new hydrogen rocket engine... Bulletin 3012-X9.



Airborne, transistorized system for vibration monitoring of turbine engines... Bulletin 3011-X8.

Rocket fuel process control system for rapid data... Bulletin 3016-X7.

High speed data translator and editor system for processing jet air safety data... Bulletin 3021-X9.

Missile ground support system for countdown and pre-countdown checkout... Bulletin 3017-X9

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General Dynamics Leads Military Contractors; Boeing Is Second

Washington — General Dynamics Corp. received defense prime contracts amounting to nearly $1.5 billion in 1959 to move into top position among military contractors.

In a summary of major 1959 awards, Defense Department reported General Dynamics replaced Boeing Airplane Co. as its top contractor. In the second spot, Boeing received awards totaling $1.18 billion. These were the only firms to receive more than $1 billion for military work.

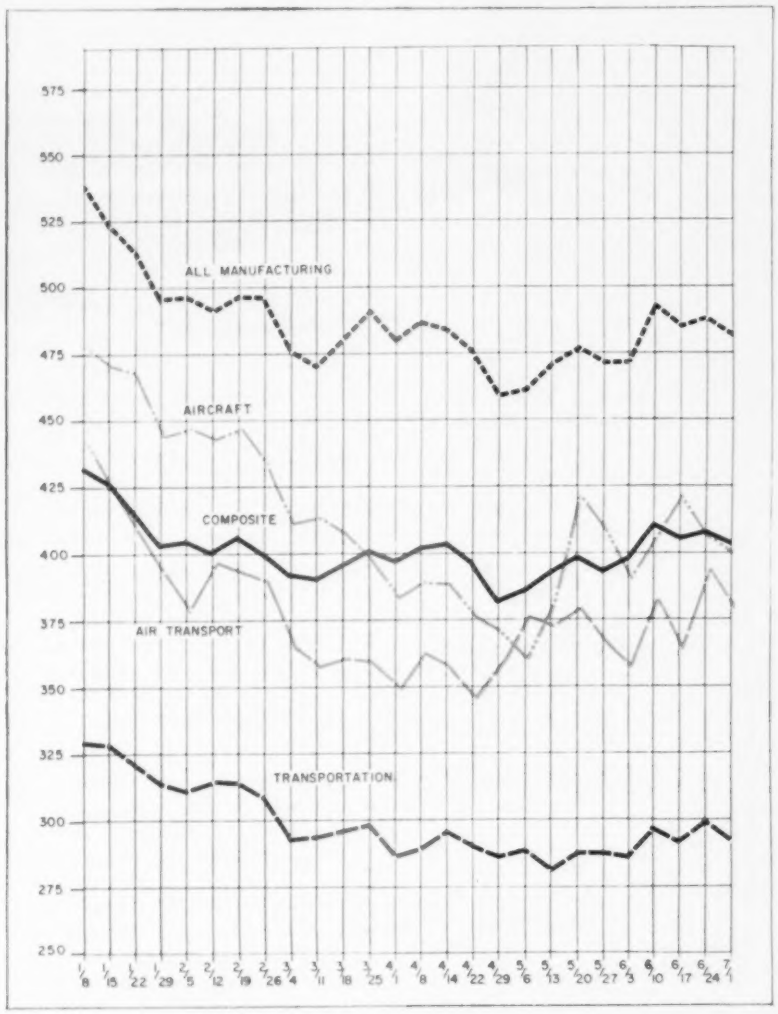
Defense last year awarded $21.7 billion in prime contracts. The 100 top companies and their subsidiaries received $15.9 billion, or 73.2% of the total.

Advances from the 1958 defense contract list were made by Lockheed Aircraft Corp. and North American Aviation, Inc., both up one place to third and fourth respectively; Grumman Aircraft and Engineering Corp. from 47th to 12th; Avco Corp. from 31st to 20th, and Thiokol Chemical Corp. from 39th to 25th.

General Electric Co. dropped from third place to fifth; Chrysler Corp. from 12th to 28th; Republic Aviation from 11th to 26th; Northrop Corp. from 20th to 41st, and Curtiss-Wright from 24th to 39th.

These are the top 100 firms and their subsidiaries, listed in rank, with dollar value of prime contracts and per cent of defense total:

RANK	COMPANIES	MILLIONS OF DOLLARS
	U. S. TOTAL[a]	$21,728.1
	TOTAL, 100 COMPANIES AND THEIR SUBSIDIARIES[b]	15,908.7
1.	**General Dynamics Corp.**	1,491.1
	Electronic Control Systems, Inc.	c
	Total	1,491.1
2.	**Boeing Airplane Co.**	1,180.5
3.	**Lockheed Aircraft Corp.**	883.5
	Lockheed Aircraft Service, Inc.	29.6
	Lockheed Aircraft Service International, Inc.	5.7
	Lockheed Air Terminal, Inc.	0.1
	Lockheed Electronics Co.	9.8
	Puget Sound Bridge & Dry Dock Co.	4.2
	Total	932.9
4.	**North American Aviation, Inc.**	925.2
5.	**General Electric Co.**	915.6
	International General Electric Co., Inc. (Puerto Rico)	0.1
	Total	915.7
6.	**Martin Co.**	584.8
7.	**Douglas Aircraft Co.**	556.7
8.	**United Aircraft Corp.**	508.4
9.	**American Telephone & Telegraph Co.**	0.6
	Chesapeake & Potomac Telephone Co.	c
	Teletype Corp.	15.3
	Western Electric Co.	485.5
	Total	501.4
10.	**McDonnell Aircraft Corp.**	402.4
	Raytheon Co.	369.4
	Sorenson & Co.	0.1
	Total	369.5
12.	**Grumman Aircraft Engineering Corp.**	334.9
	Dynamic Developments, Inc.	0.1
	Total	335.0
13.	**Hughes Aircraft Co.**	322.7
14.	**Sperry Rand Corp.**	299.2
	Vickers, Inc.	19.5
	Wheeler Electronic Corp.	c
	Total	318.7
15.	**Radio Corp. of America**	303.2
16.	**Bendix Aviation Corp.**	279.4
	Bendix-Westinghouse Automotive Air Brake Co.	0.3
	Sheffield Corp.	0.2
	Total	279.9



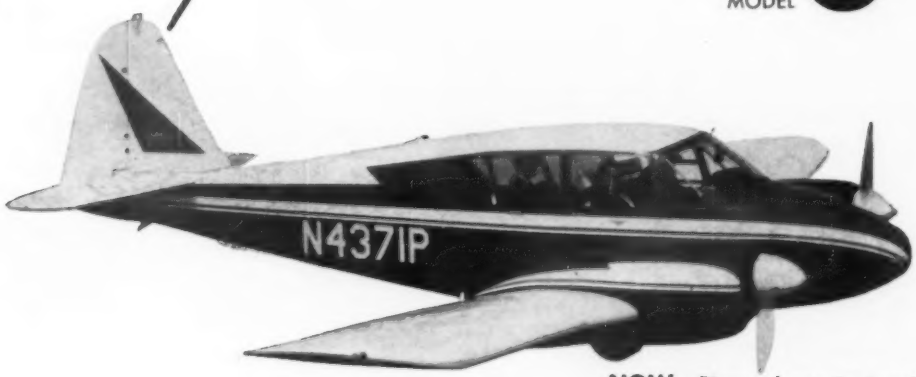
Aviation Stock Prices Show Some Recovery

Both aircraft manufacturing and airline stock prices showed signs of recovery in the second quarter of 1960 after drastic declines that accelerated in the first quarter. The sharp reaction of aircraft stocks after the U-2 went down in Russia can be noted beginning with the week of May 6. Rebound in airline stocks occurred after the Civil Aeronautics Board announced its rate of return decision. The chart is based on Securities and Exchange Commission compilations and on SEC's index in which the base year—1939—equals 100.

NOW!

Apache

MODEL **G**



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Other new improvements, too. New, easier nose wheel steering and lighter in-flight rudder loads; new, improved, more finely adjustable high-heat carburetor system; higher generator capacity (50 amps); higher permissible gear-down (150 mph) and flap-down (125 mph) speeds.

And inherent in the Apache G is the most important feature you want in any airplane... *dependability*. Dependability of components... dependability of systems... dependability of power plants... dependability that's the net result of design refinement and improvement dictated by millions and millions of hours of operation world-wide... dependability that's been proved out in well over 100 trans-Atlantic and trans-Pacific ferry flights.

The Apache G gives you the most economical twin-engine transportation, too, with lowest direct operating expense plus lower insurance cost, lower depreciation because it's priced far lower than any other twin... **still only $36,990.**

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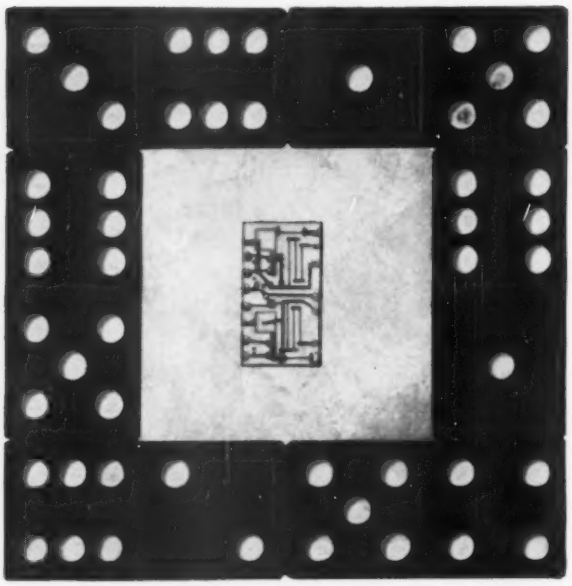
Lock Haven, Pennsylvania

RANK	COMPANIES	MILLIONS OF DOLLARS
17.	**International Business Machines Corp.**	262.2
	Service Bureau Corp.	0.3
	Total	262.5
18.	**Westinghouse Electric Corp.**	220.5
	Westinghouse Electric Supply Co.	c
	Total	220.5
19.	**General Tire & Rubber Co.**	5.1
	Aerojet-General Corp.	200.9
	Byers (A.M.) Co.	0.6
	Total	206.6
20.	**Avco Corp.**	199.6
21.	**General Motors Corp.**	193.6
	Ethyl Corp.[c]	0.3
	Frigidaire Sales Corp.	c
	Total	193.9
22.	**Newport News Shipbuilding & Dry Dock Co.**	192.4
23.	**Standard Oil Co. (N.J.)**	0.0
	Carter Oil Co.	11.1
	Enjay Co., Inc.	0.1
	Esso Export Corp.	81.4
	Esso Research & Engineering Co.	2.4
	Esso Standard Oil Co.	65.2
	Esso Standard Oil Co. (Puerto Rico)	c
	Ethyl Corp.[c]	0.3
	Gilbert & Barker Mfg. Co.	0.1
	Humble Oil & Refining Co.	11.4
	Penola Oil Co.	1.9
	Standard Vacuum Oil Co.[f]	3.7
	Total	177.6
24.	**International Telephone & Telegraph Co.**	86.5
	Federal Electric Corp.	69.0
	International Standard Electronics Corp.	c
	Kuthe Laboratories, Inc.	1.3
	Royal Electric Corp.	0.1
	Total	156.9
25.	**Thiokol Chemical Corp.**	142.5
	National Electronics Laboratories, Inc.	0.2
	Total	142.7
26.	**Republic Aviation Corp.**	140.5
27.	**Chance Vought Aircraft, Inc.**	140.2
28.	**Chrysler Corp.**	137.9
	Chrysler Airtemp Sales Corp.	2.0
	Total	139.9
29.	**Thompson Ramo Wooldridge, Inc.**	50.5
	Bell Sound Systems, Inc.	0.2
	Pacific Semiconductors, Inc.	0.3
	Space Technology Laboratories, Inc.	82.0
	Total	133.0
30.	**Burroughs Corp.**	111.3
	Control Instrument Co.	6.6
	Total	117.9
31.	**Standard Oil Co. of California**	71.9
	American Bitumuls & Asphalt Co.	0.1
	California Co.	0.1
	California Oil Co.	0.1
	California Spray Chemical Co.	0.1
	Caltex Oil Products Co.[g]	39.2
	Standard Oil Co. of Texas	5.4
	Total	116.9
32.	**Collins Radio Co.**	116.3
	Communication Accessories, Inc.	0.1
	Total	116.4
33.	**Bethlehem Steel Corp.**	0.0
	Bethlehem Pacific Coast Steel Corp.	3.9
	Bethlehem Sparrows Point Shipyard, Inc.	0.3
	Bethlehem Steel Co.	110.0
	Bethlehem Steel Export Co.	c
	Total	114.2
34.	**Merritt-Chapman & Scott Corp.**	1.0
	Devoe & Raynolds Co., Inc.	0.6
	New York Shipbuilding Corp.	103.9
	Tennessee Products & Chemical Corp.	0.3
	Total	105.8
35.	**Philco Corp.**	101.7
	Lansdale Tube Co.	0.2
	Sierra Electronics Co.	0.1
	Total	102.0
36.	**American Bosch Arma Corp.**	98.2
37.	**Minneapolis-Honeywell Regulator Co.**	94.8
	Marion Electrical Instrument Co.	c
	Total	94.8
38.	**Pan American World Airways, Inc.**	89.1
	Pan American Grace Airways, Inc.	c
	Total	89.1
39.	**Curtiss-Wright Corp.**	89.0
40.	**Goodyear Tire & Rubber Co.**	22.1
	Goodyear Aircraft Corp.	61.5
	Goodyear Engineering Corp.	1.3
	Total	84.9
41.	**Northrop Corp.**	78.3
	Page Communications Engineers, Inc.	5.2
	Total	83.5
42.	**Marquardt Corp.**	78.2
	Cooper Development Corp.	1.2
	Total	79.4
43.	**Continental Motors Corp.**	31.0
	Continental Aviation & Engineering Corp.	47.3
	Gray Marine Motor Co.	0.1
	Wisconsin Motor Corp.	0.1
	Total	78.5
44.	**General Precision Equipment Corp.**	0.0
	GPE Controls, Inc.	0.1
	General Precision Laboratory, Inc.	11.1
	Graflex, Inc.	0.8
	Griscom-Russell Co.	0.3
	Hertner Electric Co.	c
	Kearfott Co., Inc.	17.3
	Librascope, Inc.	37.2
	Link Aviation, Inc.	10.3
	Strong Electric Corp.	0.5
	Total	77.6
45.	**Texaco, Inc.**	29.3
	Caltex Oil Products Co.[g]	39.2
	Texaco Brazil, Inc.	0.2
	Texaco Co. (Puerto Rico), Inc.	0.8
	Texas Petroleum Co.	3.2
	Total	72.7
46.	**Garrett Corp.**	69.4
47.	**Morrison-Knudsen-Hardeman-Drake-Olson-Young[h]**	67.6
48.	**Massachusetts Institute of Technology**	64.7
49.	**Socony Mobil Oil Co.**	44.1
	General Petroleum Corp.	10.3
	Magnolia Petroleum Co.	1.6
	Mobil Overseas Oil Co., Inc.	3.6
	Standard Vacuum Oil Co.[f]	3.7
	Total	63.3
50.	**Ford Motor Co.**	52.6
	Aeronutronic Systems, Inc.	7.5
	Total	60.1
51.	**Hercules Powder Co.**	59.4
52.	**Bell Aircraft Corp.**	16.2
	Bell Helicopter Corp.	42.3
	Hydraulic Research Mfg. Co.	0.2
	Lord Chemical Corp.	c
	Wheelabrator Corp.	0.1
	Total	58.8
53.	**Westinghouse Air Brake Co.**	0.4
	Le Tourneau-Westinghouse Co.	1.8
	Melpar Inc.	56.0
	Total	58.2
54.	**Hoffman Electronics Corp.**	57.1
55.	**Ford Machinery & Chemical Corp.**	54.8
56.	**Hazeltine Corp.**	54.2
57.	**Ingalls Iron Works Co.**	c
	Ingalls Shipbuilding Corp.	52.5
	Ingalls Taiwan Shipbuilding Corp.	c
	Total	52.5
58.	**General Telephone & Electronics Corp.**	0.0
	Automatic Electronic Sales Co.	3.1
	Lenkurt Electric Co.	0.3
	Sylvania Electric Products, Inc.	48.5
	Total	51.9
59.	**International Harvester Co.**	47.4
	Hough (Frank G.) Co.	2.7
	Total	50.1
60.	**Greenland Contractors[b]**	46.8
61.	**Olin Mathieson Chemical Corp.**	45.3
	Liberty Powder Co.	0.9
	Liberty Powder Defense Corp.	0.5
	Total	46.7
62.	**Continental Oil Co.**	39.6
	Malco Refineries, Inc.	6.1
	Total	45.7
63.	**Shell Caribbean Petroleum Co.**	24.6
	International Lubricant Corp.	0.5
	Shell Chemical Corp.	0.6
	Shell Development Co.	0.3
	Shell Oil Co.	19.2
	Total	45.2
64.	**Temco Aircraft Corp.**	41.2
	Fenske Fedrick & Miller, Inc.	0.6
	Total	41.8
65.	**Ryan Aeronautical Co.**	41.8
66.	**Kaman Aircraft Co.**	39.0
67.	**Lear, Inc.**	37.9
68.	**American Machine & Foundry Co.**	37.4
	AMF Overseas Corp.	c
	Potter & Brumfield, Inc.	0.2
	Thompson Brewer & Co.	c
	Total	37.6
69.	**System Development Corp.**	35.9
70.	**Standard Coil Products Co., Inc.**	c
	Kollsman Instrument Corp.	35.4
	Total	35.4
71.	**Magnavox Co.**	34.9
72.	**Goodrich (B. F.) Co.**	33.9
73.	**Hayes Aircraft Corp.**	33.9

FROM LABORATORY CURIOSITY TO MISSILE TRAJECTORY...



MICROELECTRONIC GRAY MATTER FOR

TOMORROW'S air and sea launched ballistic missiles will fulfill a pivotal role in the nation's retaliatory arsenal. Directing their flight will be revolutionary guidance computers, miniaturized to a point far beyond the limit of conventional design techniques.

But before this degree of miniaturization can be achieved in a computer *that must be more than a laboratory curiosity* a radically new design philosophy must be applied.

Engineers at G.E.'s Light Military Electronics Department are meeting the challenges of size and sophistication by pursuing a predominantly *functional* approach to micro-electronics...exploiting the versatility of tunnel diodes and other semiconductors in conjunction with thin film circuit wafers.

And by designing *for* microminiaturization from the start, not only is it feasible to achieve far greater component densities – the development of standardized circuits and functional modules also reduces the numbers of components and connection interfaces, significantly enhancing predicted reliability.

MISSILE GUIDANCE

Electronics engineers with experience and interest in this burgeoning field are invited to write informally for additional technical data or information on specific professional opportunities.

Address inquiries to Mr. R. Bach, Department 64-WD.

LMED

LIGHT MILITARY ELECTRONICS DEPARTMENT

GENERAL ELECTRIC

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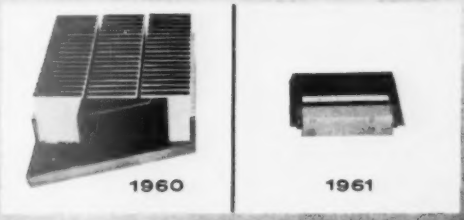
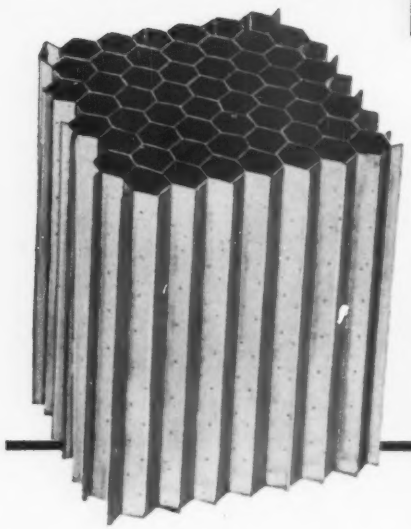
"FRATERNAL TWINS"

The unit at left represents a missile-borne computer developed by Light Military and miniaturized by conventional techniques to near the limit of 1960's state of the art. The 1961 experimental model along side (providing equivalent function) will be designed for microelectronics employing LMED's thin film wafers in modular construction. It is about 1/20th the size of its "fraternal twin."



HONEYCOMB as an energy absorber



- • • for G-limiting personnel protection devices
- • • for protecting air-dropped supplies
- • • for impact limiting safety linkages
- • • for missile instrument recovery assemblies
- • • and other applications to limit destructive G-loads to pre-determined levels

While honeycomb materials are used principally in light-weight, high-strength sandwich structures, increasing emphasis has been placed on the use of honeycomb to control forces exerted on decelerating objects. Such control is highly desirable in cushioning the impact of air-dropped supplies, protecting instrumented missile assemblies, providing impact-limiting linkages in landing gear structures, packaging fragile items, and protecting human occupants of high speed vehicles.

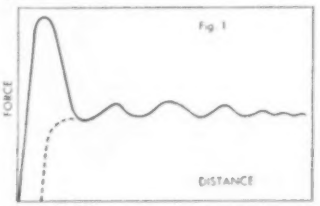
The Problem

Instances requiring impact energy absorption are generally typified by low tolerable deceleration rates for the structure or its contents, high impact velocities, and small maximum allowable stopping distances. Such absorbers as mechanical springs, sponge or solid rubber, foams, cork, and wadding generally exhibit spring characteristics, in that the force transmitted through these absorbers to the object being stopped increases continuously through the distance in which the absorbers contract. In addition, many of these materials do not absorb energy, but merely store it for release as rebound energy.

If an absorber could exert a relatively constant non-rebound force throughout the entire stopping distance, that distance could be shortened, or alternately, the maximum force acting on the object in the same stopping distance could be materially reduced.

Advantages of Honeycomb

Honeycomb core materials tend to follow such a constant force curve, as shown in Figure 1.



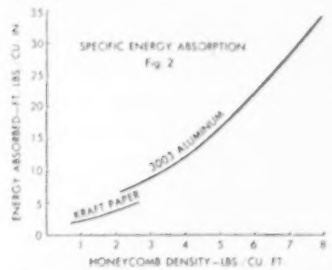
The initial peak on the curve represents the point at which compressive failure begins. This peak can be lowered by prestressing the core to produce slight initial compressive failure. When subjected to further or subsequent loading, the prestressed core proceeds immediately to carry the crushing load, as shown by the dashed line curve in Figure 1.

The main illustration shows the appearance of aluminum honeycomb core before and after compressive failure.

By designing a honeycomb core assembly with a specified cell depth this constant force can be applied over a predetermined stopping distance.

Available Materials

These principles apply to aluminum and paper honeycomb, and most similar honeycomb core materials fabricated from ductile metals and fabrics. Figure 2 indicates the general range of energy absorption capacity available in aluminum and paper materials.



These capacities can be further increased by filling the cells with various foamed materials. Detailed information is available to assist the designer in the specific selection of a core material for exact requirements.

Optimum Solution

The choice of materials by the designer will depend upon the particular requirements of the application. But it seems apparent that the utilization of honeycomb offers the optimum solution—in terms of weight and volumetric efficiency—to many types of energy absorption problems.

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RANK	COMPANIES	MILLIONS OF DOLLARS
74.	**States Marine Corp.**	20.4
	States Marine Corp. (Del.)	7.4
	Isthmian Lines	6.0
	Total	33.8
75.	**Richfield Oil Corp.**	33.6
	American Mineral Spirits Co.	0.2
	Total	33.8
76.	**Ogden Corp.**	0.0
	Avondale Marine Ways	33.7
	Commercial Filter Corp.	0.1
	Total	33.8
77.	**Jones (J. A.) Construction Co.**	33.0
78.	**Laboratory For Electronics, Inc.**	32.9
79.	**Cities Service Co.**	0.3
	Arkansas Fuel Oil Corp.	0.6
	Cities Service Gas Co.	0.3
	Cities Service Oil Co.	31.5
	Orange State Oil Co.	0.1
	Total	32.8
80.	**Mason & Hanger-Silas Mason Co.**	32.7
81.	**Kiewit (Peter) Sons Co.**	32.2
82.	**Cutler-Hammer, Inc.**	31.9
83.	**MacDonald Scott and Associates**	31.6
84.	**Oman-Farnsworth-Wright!**	31.1
85.	**Cook Electric Co.**	30.1
86.	**U. S. Rubber Co.**	29.6
87.	**Leavell-Scott and Associates**	28.6
88.	**California Institute of Technology**	28.2
89.	**Tidewater Oil Co.**	26.1
	Seaside Oil Co.	1.0
	Total	27.1
90.	**Aro, Inc.**	26.3
91.	**Overseas National Airways, Inc.**	26.0
92.	**Litton Industries, Inc.**	19.8
	Litton Industries of California	1.3
	Litton Industries of Maryland	4.8
	Total	25.9
93.	**Motorola, Inc.**	23.0
	Dahlberg Co.	0.3
	Motorola Communications and Electronics, Inc.	1.7
	Total	25.0
94.	**Gulf Oil Corp.**	20.1
	Callery Chemical Co.	3.2
	Gulf Research and Development Co.	0.1
	Mene Grande Oil Co.	1.3
	Total	24.7
95.	**Union Carbide Corp.**	24.3
96.	**Columbia University**	24.3
97.	**Gilfillan Bros., Inc.**	24.0
98.	**Eby, Martin K. Construction Co.**	23.8
99.	**Texas Instruments, Inc.**	23.6
	Geophysical Service, Inc.	0.1
	Total	23.7
100.	**Eastman Kodak Co.**	23.1
	Eastman Chemical Products	0.1
	Eastman Kodak Stores	*
	Recordak Corp.	0.4
	Total	23.6

FOOTNOTES:

* Net value of new procurement actions minus cancellations, terminations and other credit transactions. The data include debit and credit procurement actions of $10,000 or more, under military supply, service and construction contracts for work in the U. S.;

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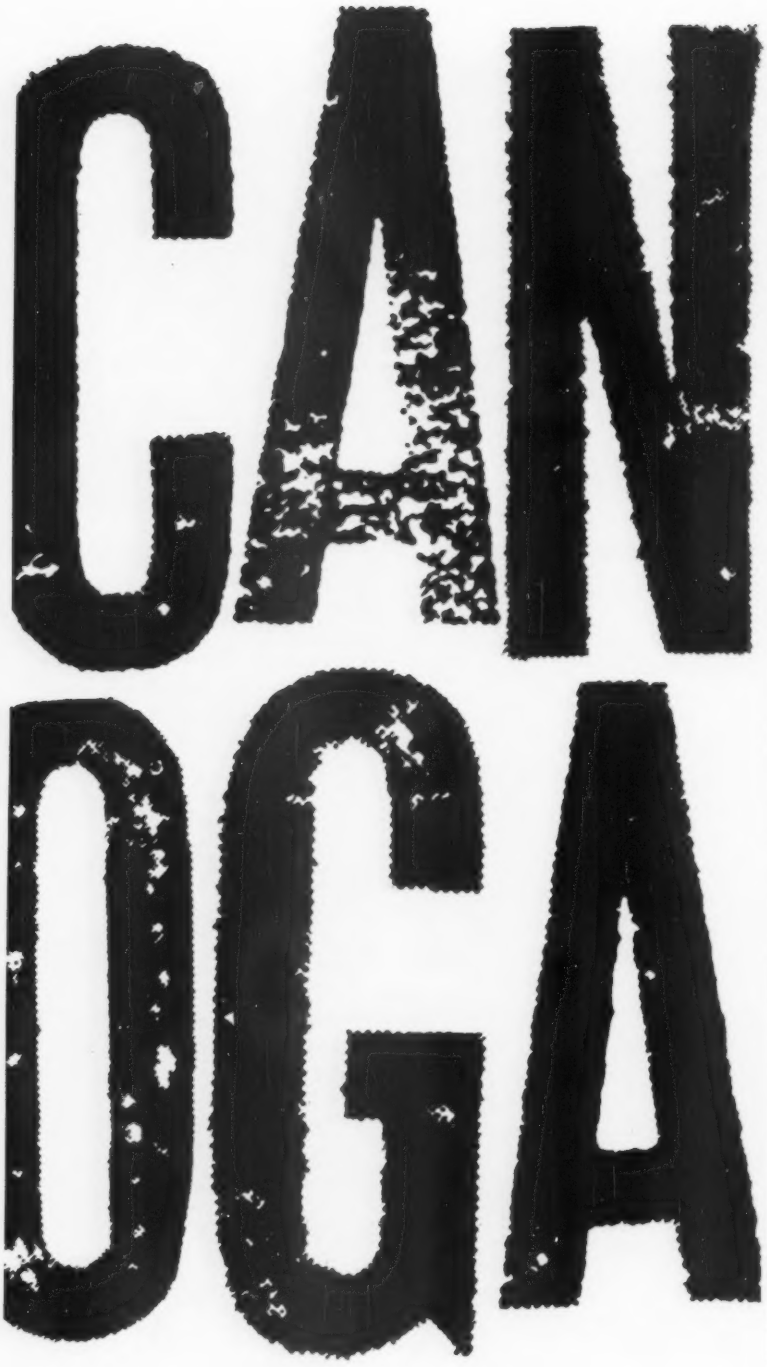
Look, get the name of the company up there, BIG... in big block letters and tell 'em what we do!
See whiz and ginger snaps, GH... what DOES this company make anyway... now that I think of it?
Who gave YOU a key to the washroom? We do a few little things like making radar sets, communication and telemetry antennas...
...missile range instrumentation and digital data processing and test equipment and...
Schoobee doobee doo!
GEE!
...and microwave components and electronics and electromechanical devices and...
And in BIG, BLOCK LETTERS, see... so when they turn the page the image still is there!
I can see it right now, GH, sir. Great idea!



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plus awards to listed companies and other identifiable U. S. companies for work overseas.

Procurement actions include definitive contracts, the obligated portions of letter of intent and letter contracts, purchase orders, job orders, task orders, delivery orders, and any other orders against existing contracts. The data do not include that part of open-end or indefinite quantity contracts that have not been translated into specific orders on business firms. The data do not include purchase commitments or pending cancellations that have not yet become mutually binding agreements between the government and the company.

[b] The assignment of subsidiaries to parent companies is based on stock ownership of 50% or more by the parent company, as indicated by data published in standard industrial reference sources. The company totals do not include contracts made by other U. S. government agencies and financed with Department of Defense funds, or contracts awarded in foreign nations through their respective governments. The company names and corporate structures are those in effect as of Dec. 31, 1959. Only those subsidiaries are shown for which procurement actions have been reported.

[c] Less than $50,000.

[d] Less than 0.05%.

[e] Stock ownership is equally divided between General Motors Corp. and Standard Oil Co. of New Jersey; half of the total military awards is shown under each of the parent companies.

[f] Stock ownership is equally divided between Standard Oil Co. of New Jersey and Socony Mobil Oil Co.; half of the total of military awards is shown under each of the parent companies.

[g] Stock ownership is equally divided between Standard Oil Co. of California and Texaco, Inc.; half of the total of military awards is shown under each of the parent companies.

[h] A joint venture of Morrison-Knudson Co., Inc., Paul Hardeman, Inc., Johnson-Drake & Piper, Inc., Olson Construction Co., and Young (F. E.) Construction Co.

[i] A joint venture of Klewit (Peter) Sons, Inc., Groves (S. J.) Sons Co., Johnson (Al) Construction Co., and Condon Cunningham, Inc.

[j] A joint venture of Oman Construction Co., Farnsworth (R. P.) Co. and Wright Contracting Co.

1960 First-Quarter Aviation Exports Rose

Washington—Aviation exports totaling $267 million during the first quarter of this year showed a 46% gain over the comparable 1959 period, according to Aerospace Industries Assn.

AIA reported these exports:

- **New transport aircraft,** 29 units with a value of $73 million. This compared with nine units valued at $10.8 million for the first quarter 1959.
- **Utility aircraft,** 324 units with a value of $4.6 million, compared with 199 units valued at $2.7 million for the first three months of 1959.

Martin Acquires Interest In Nuclear Corporation

George M. Bunker, chairman of the board of The Martin Co., announced that Martin had acquired a substantial interest in the outstanding stock and debentures of the Nuclear Corporation of America. Mr. Bunker said the companies have a common interest in the nuclear and electronics fields.

CAB Accident Investigation Report:

CAB Reports Findings in Crash Of Mooney Model 18 Lightplane

On Sept. 7, 1959, about 1430[1] EDT, a Mooney M-18C55, N 4174, crashed 1½ mi. west of the Culmerville Airport near Butler, Pa. Donald W. Bailey, the pilot and sole occupant, received fatal injuries. The airplane, a single-engine, single-place, low-wing monoplane, was demolished.

Mr. Bailey planned a local VFR flight of 20 min. duration. He was seen to take off in N 4174 and climb to about 1,500 ft. northwest of the airport where he executed several "lazy-eight" maneuvers. At approximately 1430 several persons on the ground saw the aircraft in straight and level flight on a southerly heading. A loud crack was heard and parts were seen to separate from the aircraft. Immediately thereafter N 4174 entered a spin and crashed.

The Board concludes that this accident was caused by the inflight separation of the trailing edge member of the right horizontal stabilizer. Investigation revealed very poor bonding of the glued wood joints of this structure due to improper production techniques. In addition, evidence was found throughout the aircraft of poor design and production practices in both welded metal parts and glued wood joints.

As a result of this investigation and the Board's recommendations, an Airworthiness Directive was issued by the administrator of the Federal Aviation Agency (see p. 123).

Investigation

Mr. Bailey possessed a currently effective FAA commercial pilot certificate with a rating for single-engine land airplanes and an instrument rating. He had accumulated about 900 flying hours. Mr. Bailey's total flight experience in N 4174 was 1 hr. 40 min.

The flight on which the crash occurred was a proficiency flight in the local area and was to be of 20 min. duration. The weather conditions were: ceiling and visibility unlimited. The surface wind was from the west-southwest at 5 mph.

Mr. Bailey took off on the west runway about 1415. He circled the airport climbing to an altitude of about 1,200-1,500 ft. above ground. About 1-1½ mi. northwest of the airport he was observed executing "lazy-eight" maneuvers.[2]

At approximately 1430, several persons on the ground saw the Mooney aircraft. They stated that it was proceeding in a southerly direction in straight and level flight. Several stated that they heard a loud sharp crack and saw objects separate from the aircraft. Several others heard the sound and then observed the aircraft in a spin with pieces falling behind it. Immediately thereafter the aircraft crashed 1½ mi. west of the Culmerville Airport. There was no fire.

Structural Failure

Several aircraft parts were found back along the flight path and confirmed the observations that inflight structural failure had occurred. The right side of the horizontal stabilizer was found 2,600 ft. northwest of the main wreckage site; the right elevator was found 1,100 ft. northwest; and the fin and rudder, Plexiglas, and a piece of right wing plywood were found 550 ft. northwest of the wreckage.

The main portion of the aircraft struck the ground in a near-vertical descent. Impact damage indicated it was pitched nose down to a 30 or 40 deg. angle and yawed to the left. All components, other than those which separated in flight, were found within a 25-ft. radius of the powerplant.

The right wing spar had failed downward from inflight overloads at two points; approximately 1 ft. outboard of the attach point and 4 ft. 9 in. outboard of the attach point. The section between the two breaks was in the main wreckage with the landing gear still attached. The right flap with its hinges had separated from the wing and was bent upward in a "U" shape which corresponded closely with the curvature of the top of the fuselage midsection. The hinge welds on the flap were cracked at impact. One piece of plywood, identified as a portion of the right wing lower surface at and forward of the spar just outboard of the inboard failure, was found 550 ft. from the wreckage. The size of this piece, which was originally glued to the spar, was 10.3 in. long but showed bonding of the glued joint for only about 3.5 in.

Inspection of the right horizontal stabilizer, which separated in flight, revealed that the spar had failed at the right attach bolt in downward overload. A section of the right trailing edge member extending from a point outboard of the inboard hinge to the No. 3 rib had pulled out. It remained attached to the elevator by the middle hinge when the elevator had separated from the stabilizer. The outboard elevator hinge remained with the stabilizer. The glued joint of the No. 2 rib and the trailing edge member had separated with only slight failure of the wood. The laminated plies of the middle hinge block were also separated with no wood failure. The rearmost lamination was cracked rearward by the hinge bolt. In addition, the No. 1 rib had separated from the spar with very little wood failure.

The right elevator was found 1,100 ft. northwest of the main wreckage area. It

[1] All times herein are Eastern Daylight based on the 24-hr. clock.

[2] An advanced flight training maneuver which combines the dive, the turn, and the climb. This maneuver does not impose excessive or abnormal loads on the aircraft when properly executed.

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- **Systems packaging research** — engineering design and development for ground support and electronic equipment protection.
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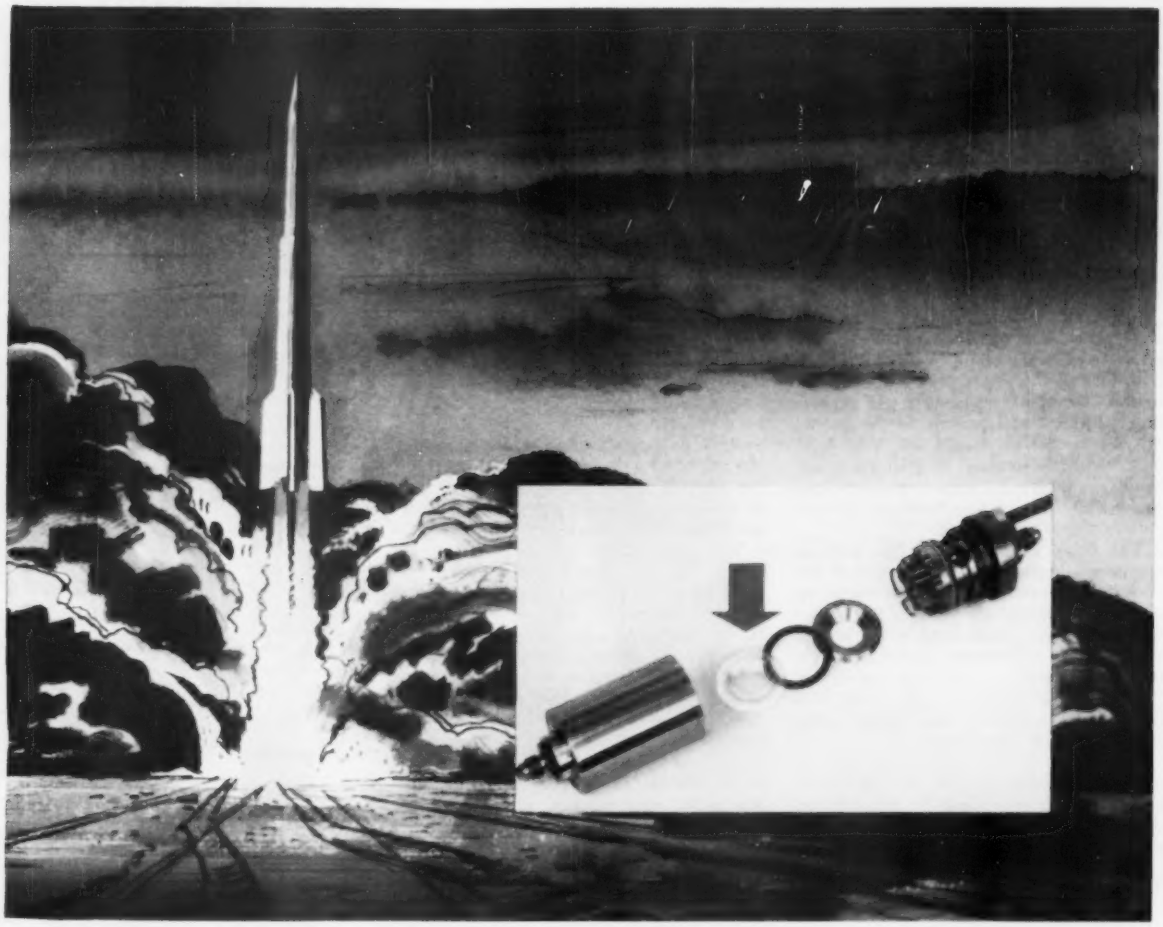

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CHEMICAL DIVISION

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3M COMPANY

was bowed spanwise so that the middle hinge was about 2 in. lower than the root and tip. The middle hinge was intact with the portion of trailing edge member mentioned above attached. The inboard and outboard hinges had separated at the upper and lower welds. These welds had very little penetration.

The vertical stabilizer failed to the left and with the rudder attached fell 550 ft. from the wreckage. When the rudder separated from the aircraft the lower hinge failed in the weld. The rib trailing edge glued butt point adjacent to the middle hinge was loose. It was being held in place by one brad and the joint showed very little wood failure.

Impact Forces

All other damage to the aircraft was the result of impact forces. There was some evidence of deterioration present in several of the glued joints which had separated with very little wood failure. In other joints, which had failed in a similar manner, there was no evidence of any deterioration. (It was noted that none of the glued joints was reinforced with gusset plates but depended entirely upon the strength of the glue to hold them.)

In view of the findings during this investigation and the fact that the Model 18 production ceased in 1956, the Board carried its investigation into Mooney Aircraft, Inc.'s, present production methods for the Model 20A. The present company, which took over control of Mooney Aircraft, Inc., in 1956, maintains a strict inspection system to check all stock as it is received into the plant to ensure conformity to specifications. Quality control of all fabricated parts is maintained by visual inspection of each operation and comparison with blueprints. In addition, a conformity report on each lot of parts has to be filled out stating the number of units inspected, the workmanship, and conformance to the drawings. Further, each step in the assembly and subassembly must be inspected and signed off before the next operation can be started.

Analysis

The evidence indicates that the initial inflight failure occurred when the glue joint of the No. 2 rib separated allowing the trailing edge member of the right horizontal stabilizer to pull out. Airload bowed the elevator down in the middle, its inboard and outboard hinges remaining intact. As the elevator was bowed downward and the lateral distance between the inboard and outboard hinges decreased, an abnormally high downward loading was consequently imposed on the stabilizer, failing it downward at its attach point. It is probable that as the stabilizer separated from the aircraft the outboard elevator hinge failed and the elevator remained attached to the aircraft momentarily until the inboard hinge also failed. This is indicated by the location of the stabilizer farther from the wreckage than the elevator.

The immediate result of the loss of the stabilizer was a violent nosedown pitching of the aircraft, which failed the right wing spar downward in two places. Following this the aircraft rolled rapidly to the right and the vertical fin separated. The aircraft

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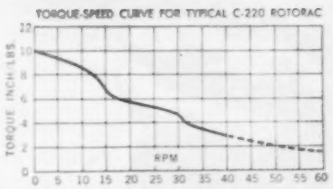

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then fell nearly vertically to the ground.

The generally poor condition of glued wood joints throughout the aircraft appears to be a result of poor production techniques. Although deterioration from weathering was noted in some which had failed, it is not believed to have been of such a degree as to cause separation with little or no wood failure. The design practice of using glued butt joints without gussets or the equivalent is considered poor. In the later Models 20 and 20A this problem is overcome because the stabilizer and wings are completely covered with plywood and this surface acts as gusset for the structure.

Similarly, poor production techniques were noted in numerous welds throughout the aircraft. Because of poor penetration, several had failed in the weld deposit or at the juncture of the weld deposit and the parent metal. The weld should, if properly made, be the strongest point in a tubular member and loads exceeding design strength of the part should fail it at a point adjacent to the weld rather than through the weld itself.

Conclusions

The Board concludes that the inflight structural failure resulted from the separation of a glued wood joint. The Board further concludes that proper bonding between the wood and glue was not obtained during production because of improper techniques and control. It is also concluded that the design practices did not provide a sufficient margin of safety to guard against weakening of the structure over a prolonged period.

As a result of recommendations made by the Board to the administrator of the Federal Aviation Agency following this investigation, the latter issued an airworthiness directive to correct these deficiencies.

Probable Cause

The Board determines that the probable cause of this accident was an inflight structural failure brought about by the separation of an improperly glued wood joint.

By the Civil Aeronautics Board:

WHITNEY GILLILLAND
Chairman

CHAN GURNEY
Vice Chairman

G. JOSEPH MINETTI
Member

ALAN S. BOYD
Member

Supplementary Data

The Civil Aeronautics Board was notified of this accident shortly after it occurred on Sept. 7, 1959. An investigation was immediately initiated in accordance with Section 701(a) (2) of the Federal Aviation Act of 1958. Depositions ordered by the Board were taken at the Culmerville Airport, Culmerville, Pa., on Oct. 13, 1959, and in Kerrville, Tex., on Oct. 15, 1959.

The Aircraft

N 4174, a Mooney M-18C55, manufacturer's serial number 339, was manufactured July, 1955. A production test flight was performed on Apr. 30, 1956, and the aircraft found to be airworthy. It was classified in the standard category. A current certificate of airworthiness was is-

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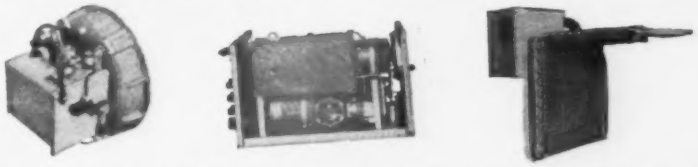

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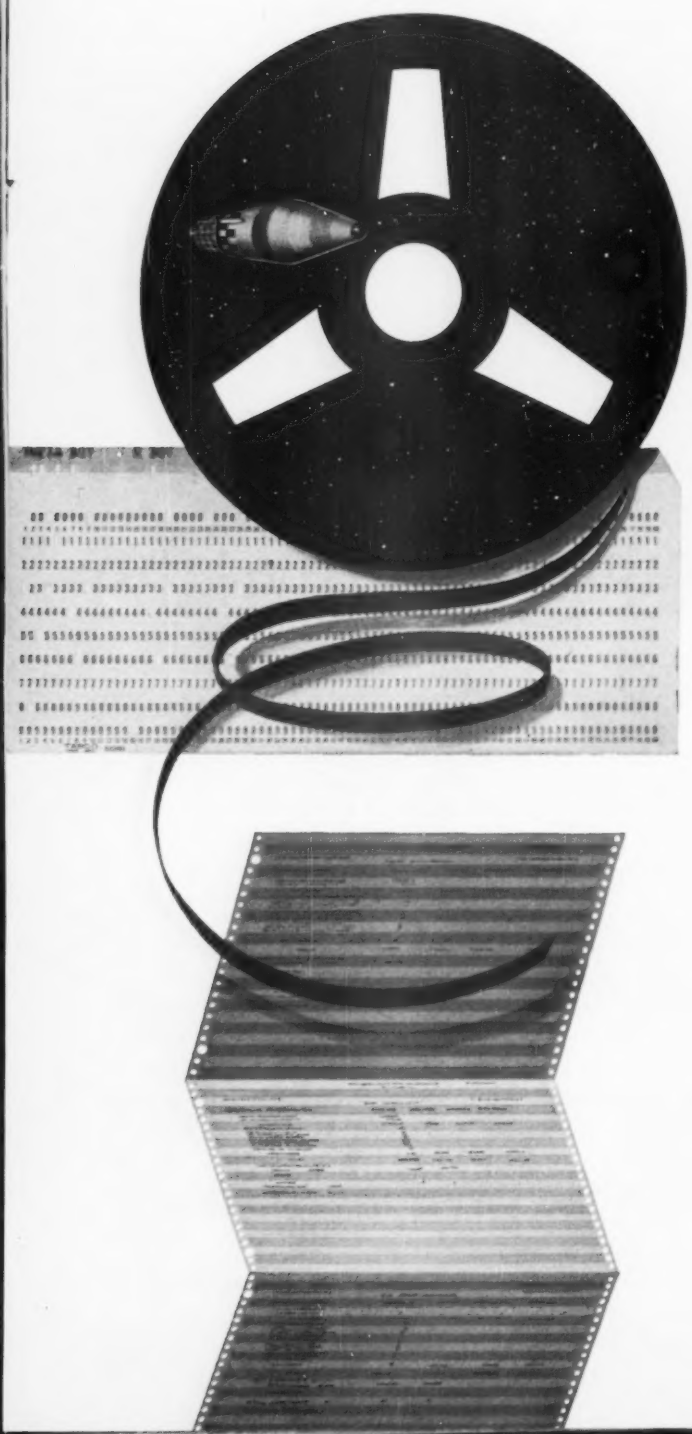

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sued Jan. 5, 1959. The current certificate of registration, dated Sept. 2, 1959, listed Fred O. Eiler of Tarentum, Pa., as the owner. The aircraft and engine had a total of 356 hr., of which 6 hr. had been accumulated since the last 100-hr. inspection Aug. 26, 1959. It was equipped with a Continental engine, A65-12, and a Flottrop propeller, 65A66, installed new on May 21, 1959.

The Pilot

Donald W. Bailey, age 24, resided at Gibsana, Pa. He possessed a currently effective FAA commercial pilot certificate with an airplane single-engine land and an instrument rating. He had accumulated approximately 900 flying hours, of which 1 hr. 40 min. were in the Mooney M-18.

FAA Airworthiness Directive

Mooney: (Applies to all Mooney M-18 series aircraft). Compliance required within the next 10 flight-hours but not later than Dec. 15, 1959.

The following inspections, repairs, and replacements shall be accomplished:

(a) Empennage:

(1) Remove and disassemble empennage. Remove control surface and hinge brackets from fin and horizontal stabilizer. Remove bolts through stabilizer main spar atttach blocks. Disassemble stabilizer and fin from empennage truss and each other.

(2) Inspect all bolted joints for the following items:

(i) Wear on bolt.

(ii) Wear on bolt holes in fittings and lugs.

(iii) Wear on bushing.

(iv) Wear on bushing on fittings, lugs and wood. (Replace parts as necessary.)

(3) Remove all fabric from stabilizer and fin. Inspect all wood and glue joints including attachment of leading edge skin to main spar for deterioration.

(4) At center section of stabilizer spar inspect glue joint between attach blocks and spar for deterioration and inspect spar and blocks for cracks. Inspect fin spar for cracks at attach bolts.

(5) Any defective wood parts shall be replaced or repaired in accordance with CAM 18 and/or manufacturer's recommendations. When the fin and stabilizer are satisfactory, reinforcement of the stabilizer main spar center section and the fin and stabilizer center hinge rib-rear spar attachment shall be accomplished in accordance with Mooney M-18 Service Letter No. 16. (Kits of reinforcement parts are available from Mooney Aircraft, Inc.)

(6) Clean all empennage drain holes, and see that they are located as specified in Mooney M-18 Service Letter 16.

(7) Inspect welds at rudder and elevator hinges and control horns and at all joints on the tail truss for inadequate welds (i.e. weld which does not fill fillet cross section area) and for cracks using either method (i) or (ii) below.

(i) Magnetic particle or X-ray inspection.

(ii) Remove paint and primer and visually inspect welds with a 10-power glass.

Parts with defective welds are to be replaced or repaired. A joint may be rewelded providing the old weld is removed and the surfaces thoroughly cleaned.

(8) Remove upper tail truss attach fittings from aft fuselage bulkhead and inspect as described in item (2). Inspect bulkhead front and back for cracks in area of these fittings. Inspect glue joints between bulkhead and aft fuselage skin and longerons for deterioration or separation. Repair in accordance with Mooney M-18 Service Letter No. 17. Examine trim linkage attached to lower part of aft bulkhead for worn bolts. Replace bolts as necessary.

(9) Reassemble and install empennage making sure all bolts are tight. Block airplane solidly at tail skin and inspect for empennage play as follows:

(i) Stabilizer—Move up and down at one tip and measure at opposite tip. Total allowable play ½ in. up and down.

(ii) Stabilizer—Move fore and aft at one tip and measure at opposite tip. Total allowable play ¾ in. fore and aft.

(iii) Fin—Move fore and aft at top leading edge and measure at bottom of rudder trailing edge. Total allowable play ½ in. up and down.

(b) Aft Fuselage:

(1) Inspect wood around forward fuselage tubular structure attach fittings for deterioration. Clean all drain holes. Inspect all glue for deterioration. See that drain holes are located as specified in Mooney M-18 Service Letter 16.

(c) Wing:

(1) Remove seat, auxiliary fuel tank and belly access panel. Inspect ribs, skin and both spars at lower center section and around fuelage fittings for wood and glue joint deterioration.

(2) Inspect all wood and glue joints in wheel weld area for deterioration. Inspect both spars for cracks in area of the gear attachments.

(3) Inspect interior of wing in areas having access openings.

(4) Remove aileron and inspect hinges and control horn in accordance with part (a), item (7).

(5) Remove wing fabric locally in area of aileron hinges and at inboard corner of aileron cutout and check condition of wood and glue joints. If evidence of deterioration is found remove fabric further as necessary for complete examination of forward area of wing trailing edge. Check security of attachment of wing trailing edge in aileron area.

(6) Clean all drain holes in wing, and see that they are located as specified in Mooney M-18 Service Letter 16.

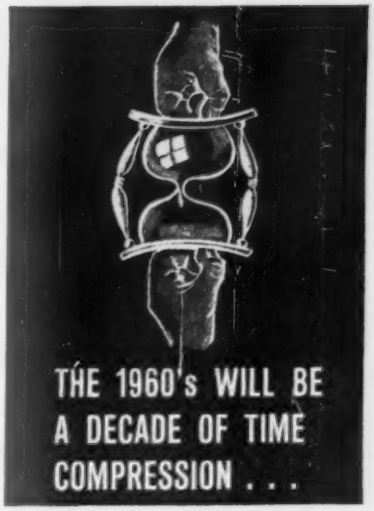
(d) Control Systems:

(1) Inspect all control systems (aileron, trim, rudder, and elevator).

(i) Visually inspect all welds for cracks and inadequate welds (i.e., welds which do not completely fill fillet cross section area).

(ii) Check security of all bolted hinge and fitting attach points.

(Mooney M-18 Service Letters Nos. 16 and 17 pertain to this same subject.)



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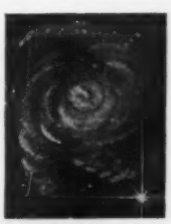

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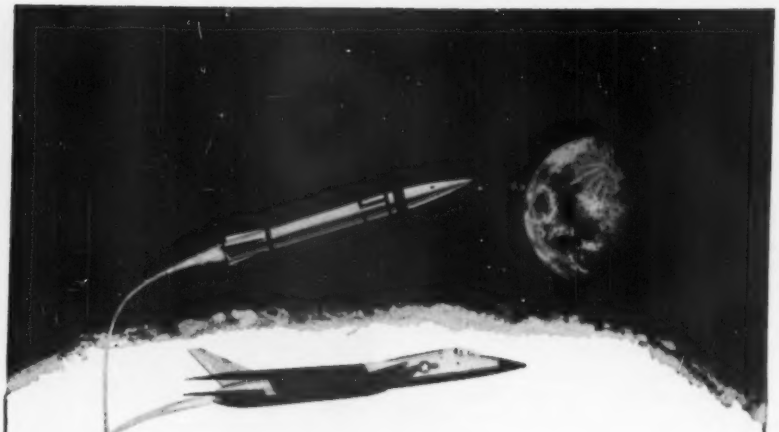

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WHO'S WHERE

(Continued from page 23)

Honors and Elections

The Flight Safety Foundation's Award of Merit, for distinguished service in achieving safe utilization of aircraft, has been presented to **John Bryce Bartow**, president and chief of research of Bartow Beacons, Inc. The citation noted that the high intensity runway lighting system developed by Mr. Bartow "is standard with the Federal Aviation Agency, the U. S. Air Force and the U. S. Navy . . ."

N. S. Hopkins, manager of Lockheed Missile Space Division at the Air Force Missile Development Center, Holloman AFB, N. M., has been elected chairman of the Holloman Test Directors' Council. **E. W. Bode**, chief of the AFMDC Field Test Group of Radioplane, was elected vice chairman.

Dr. Robert J. Jeffries, president of Data-Control Systems, Inc., has been appointed a member of an ad hoc committee established by the Division of Engineering and Industrial Research of the National Academy of Sciences, National Research Council, to prepare an analysis of the role of patents in research.

Changes

John L. Koushouris, director of operations, Military and Industrial Systems Department, CBS Laboratories, Stamford, Conn. Also: **Renville H. McMann, Jr.**, technical manager.

Joseph D. Schantz, director of engineering, Waltham Laboratories of Sylvania Electronic Systems, Waltham, Mass., a division of Sylvania Electric Products, Inc.

Dr. Frederick W. Wendt, manager-space structures operation, Space Sciences Laboratory, General Electric's Missile and Space Vehicle Department, Philadelphia, Pa.

Herbert A. Finke, director of long range product planning, Varian Associates, Palo Alto, Calif.

Dr. Isidor I. Rabi, technical consultant to Loral Electronics Corp., New York, N. Y.

Dr. Donald Wahl, engineering staff specialist for electronics design and development, Convair (San Diego) Division of General Dynamics Corp.

F. Robert Walker, manager of marketing, Gulton Industries, Inc., Metuchen, N. J.

Leonard D. Sullivan, senior corporate representative in Washington, D. C., for Raytheon Co., succeeding Col. D. J. Bailey, resigned.

John N. Glover, district manager of the Colorado Springs, Colo, office of Stromberg-Carlson Division of the General Dynamics Corp.

Harold Jackson, manager of production and engineering, Industrial & Military Products Division, Bulova Watch Co., Inc., Flushing, N. Y. Also: **Edward Bisztyga**, manager of planning and control; **Victor Malinowski**, chief inspector.

Bristol Aircraft, Ltd., Bristol, England, has announced the following appointments: **Walter F. Gibb**, sales and service manager-aircraft; **Roger White-Smith**, deputy sales and service manager-aircraft. **Godfrey Auty** succeeds Mr. Gibb as chief test pilot.

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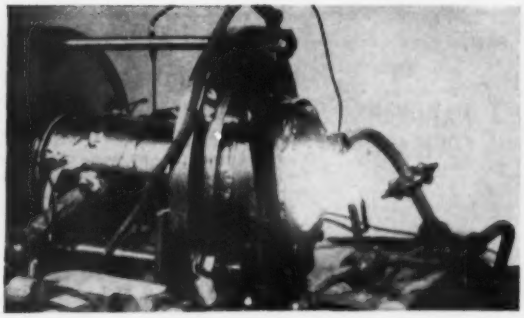

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LETTERS

Photo Realism

This is an aviation magazine for people in aviation, so let's be accurate in our reporting.

In the June 13 issue in the article on the RF-101C (p. 54) you picture a 101 as returning from a recon mission where the technicians swarm around the plane the moment the engine is cut in order to get at the camera. Yet, in the cockpit is a mechanic who looks like he is testing out the radios, a routine sort of maintenance. This is a poor attempt at realism and I think that the person who tried the whole thing ought to go back to Life magazine where he would be appreciated.

Remember, when a picture is placed in your magazine it is looked at by persons like myself who examine it in every little detail. We are in general all enthusiasts, which is the reason we pay you for your fine magazine. Oh yes, did you notice the "Sgt. Pilot" leaving the 101?

CONRAD S. LAHR, JR.
Honolulu, Hawaii

(The man leaving the aircraft (p. 57) was no sergeant but was 1st Lt. J. Wood, one of the pilots mentioned in the story. What may have struck Reader Lahr was the soft cap worn by Lt. Wood both here and in the photo of the airplane taxiing. European Editor David A. Anderton, who took the photos, points out that Lt. Wood had removed his hard hat on the way to the revetment and that the pictures were by no means posed. AVIATION WEEK appreciates demanding readers such as Mr. Lahr and is just as insistent on the same realism they seek.—Ed.)

Pilot View on Safety

Let me add a loud "Amen" to the sentiments of Roland D. Baumann's letter (AW June 27, p. 102) and thank you for the fair and objective article by David H. Hoffman in the same issue (p. 38) about the Eastern-Pan American pilots' "wildcat" strike. Flight safety is unquestionably a cooperative effort between the many organizations and individuals operating in the air transport industry. The pursuit of maximum safety in flight requires considerable mutual respect and understanding. It also requires a climate which will produce candor, open study, careful consideration, and eventual education of those operating in the field. This climate cannot exist in an atmosphere of what Mr. Baumann calls "petty arguing" and "name calling."

Your readers are entitled to hear from those who engaged in the "emotional and disorganized protest" described by Mr. Hoffman. I, for one, went to the meeting which produced the action by 151 Pan American pilots with the serious intention of trying to talk my fellow pilots out of the proposed demonstration. By the time all avenues of protest and action had been explored I became convinced that the Eastern pilots had demonstrated good sense in the course they had taken, and that no other option had been open to them or was open to us. We all fervently hope that the "wildcat" strike which ensued will be taken to heart in all quarters so that nothing like it will ever have to take place again.

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

The story has had ample coverage in the press and needs no rehash, but I should like to call attention to a few points which have been overlooked or insufficiently emphasized.

1. We pilots do not believe that the Federal Aviation Agency Administrator is against flight safety. We do believe that the great proportion of his staff are sincere, dedicated men whose efforts through the years have been and will be directed at the safe conduct of flight. There was an old popular song, "It Ain't Whatcha Do, It's the Way Thatcha Do It." I think that thought in that title might be handy for those whose office it is to regulate human beings.

2. We pilots have wives and children waiting at home for us to return from flights. It is a curious thought that we are depicted as being against regulations which will make our flying more safe.

3. The impression has been created that route inspections are the only times FAA inspectors have opportunities to check our proficiency. Two times each year we are required to demonstrate our ability to fly and meet emergencies by actually flying our aircraft without passengers through every conceivable emergency, single and double engine failures, electrical and hydraulic breakdowns, etc. FAA inspectors have an opportunity to test our proficiency on such flights, and often do. It seems reasonable that it should be on such demonstration flights without passengers that inspectors can do the close inspecting some of them seem to find necessary, and that they should limit their inspection on flights with passengers to over-all watching of the whole crew at work.

4. Airline pilots actively supported passage of the Federal Aviation Act of 1958, and felt that a good appointment had been made when the present administrator took office. We did not foresee the current climate of directive, enforcement, fine, and license suspension and revocation. In such a climate, all of us are mostly concerned with "keeping our noses clean." No pilot in his right mind these days will report a "near miss," for example, because he fears not only setting machinery in motion for the filing of a violation against a fellow pilot, but suspects he may be setting the investigators upon himself. Flight safety suffers, in such an atmosphere. Flight safety is a bundle of solutions to many complex problems. Every factor which inhibits open examination of such problems in a combined effort of all agencies and individuals to solve them is detrimental to safety.

5. When an FAA inspector required an Eastern captain—against that captain's express judgment—to rearrange his crew to let the inspector take the second copilot's seat it became a question of whether the captain was in control of the aircraft for which he was responsible. For hundreds of years on the sea, and for more than a generation in the air, there has been no such question of control authority.

I hope that the foregoing points are free from the petty arguing and name calling Mr. Baumann so rightly deplores. Reasonable men will usually agree as soon as each finds out what the other is talking about. I hope that I have maintained sufficient reasonableness and that mutual problems of all concerned with safety in flight can be appropriately aired and worked on without rancor, mutual distrust, and multiplied frustration.

WILLIAM KARRAKER, CAPT.
Pan American World Airways
New York, N. Y.

Sonic Fatigue Lab

The article, "Laboratory to Investigate Sonic Fatigue" contained in the July 4 issue of Aviation Week (p. 65) written about the sonic fatigue test laboratory facility at Dayton, Ohio, contained some omissions of professional credits properly due.

The firm of Bolt, Beranek and Newman were acoustical consultants to DMJM on the project and were responsible for the design of the sirens. Sanford L. Cassell of DMJM's Washington office was DMJM project manager for the architectural-engineering services and Gary Gould was project manager for the systems instrumentation only. We hope you may be able to note these corrections in print to an otherwise well reported and interesting story.

S. KENNETH JOHNSON
Executive Vice President
Daniel, Mann, Johnson, & Mendenhall
Los Angeles, Calif.

Space Age Milestones

As a subscriber of one year's standing, I find the gospel according to AVIATION WEEK invaluable in my business (free-lance technical articles) as regards space age data. I could literally do without my right arm sooner than your superbly documented coverage.

May I suggest one tiny thing, no more "annoying" than a mosquito perhaps, which yet might please many others as well as myself?

The suggestion: eliminate the phrase "last week" when mentioning any new satellite orbiting or any such space age milestone, and put in the exact date. To those using AW as reference, it is a bit dismaying to have to hunt elsewhere for that date when it could so easily be in our favorite reference. That one thing sums up any and all criticism I have of AW. There ain't no more.

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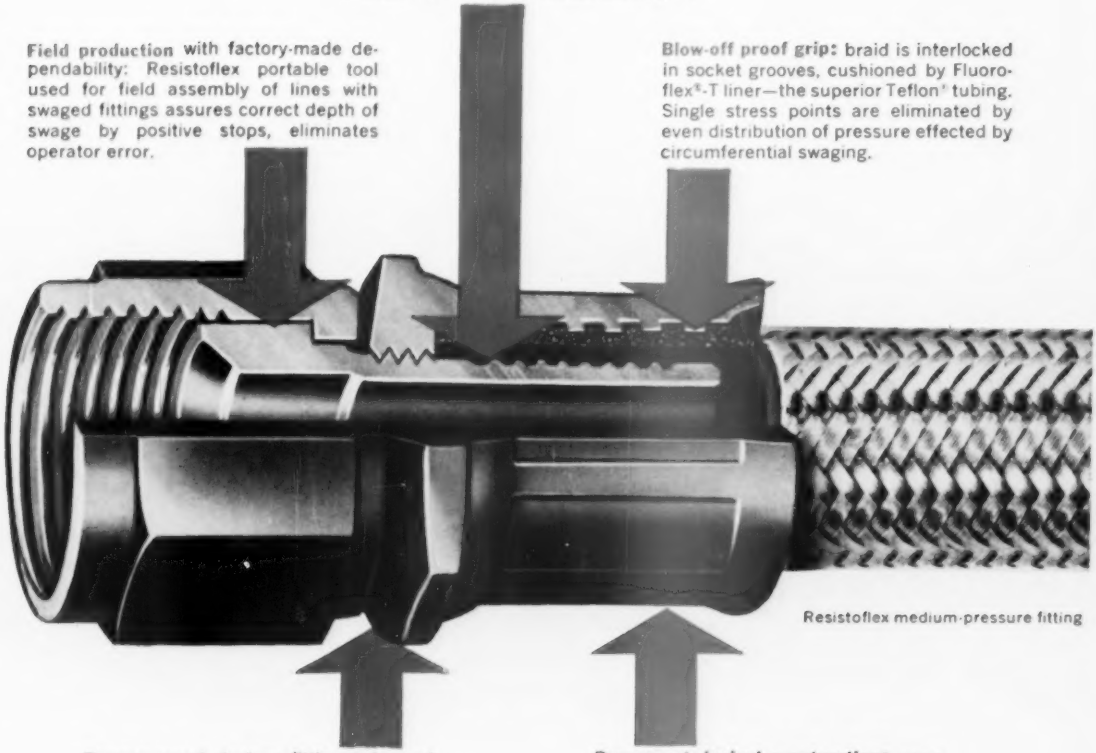

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